MAPPING LANDSCAPE VALUES AND FOREST USES

ON THE TONGASS NATIONAL FOREST

By

Britta Schroeder

RECOMMENDED:

Dr. Todd Brinkman

Dr. Peter Fix

Dr. David Verbyla, Advisory Committee Chair

Dr. John Yarie, Chair, Department of Forest Science

APPROVED:

Dr. Stephen Sparrow
Dean, School of Natural Resources and Agricultural Sciences

Dr. John Eichelberger
Dean of the Graduate School

4/21/14
Date

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Britta Schroeder, B.S.

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ABSTRACT

Throughout the world, humans are often faced with the challenge of sustaining economic development while also promoting environmental stewardship. Such is true for the management history of the Tongass National Forest, where the U.S. Forest Service is transitioning away from harvesting old-growth and moving towards a more economically and environmentally sustainable approach. To measure the preferences of local community members affected by this transition, I conducted an interdisciplinary case study on the Wrangell Ranger District in Southeast Alaska. Community members from Wrangell mapped landscape values, acceptable and unacceptable forest uses. By assessing these landscape values and forest uses with respondents' attitudes towards forest management alternatives, I identify spatial locations of conflicting timber harvest uses and recommend forest management objectives for the district. Through public participation, communities can provide spatially explicit input during the planning process, which creates opportunities for managers to incorporate community needs and better prioritize management objectives.

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ACKNOWLEDGEMENTS

"National Forests are made for and owned by the people. They should also be managed by the people." –Gifford Pinchot, The Use of the National Forests (1907)

Like a forest, this research project is made up of many stands, all of which are integral to the functioning of the system as a whole. These are the cohorts to whom I'd like to extend a sincere thank you:

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1. INTRODUCTION

In recent decades, actions by the executive, legislative, and judicial branches of the U.S. government have altered the management directives of the Tongass National Forest and have led to changes in the economic foundations of communities residing within the forest. To address the economic needs of these communities while also balancing forest management objectives, the U.S. Forest Service (USFS) has begun implementing a transition plan that promotes ecosystem health and bolsters local employment opportunities. Yet, while there is agreement between managers and stakeholders that change is necessary to meet the goals of both the social and ecological systems, the how and where of such change is still controversial. As the Tongass National Forest continues along a trajectory of change, spatially locating forest use preferences and values during project planning may help managers and communities identify areas of conflict, as well as identify those options that are most socially acceptable to contribute to the adaptive capacity of the socio-ecological system.

This research paper outlines a case study conducted in Wrangell, Alaska to explore the landscape values and forest use attitudes of community members relative to a timber harvest environmental impact statement (EIS). First, chapter 1 explains the problems arising from the history of forest management on the Tongass National Forest, describes a potential solution to these problems, and delves into the theoretical relationships supporting these solutions. Chapter 2 explains the study area and history thereof, the data collection methods, and the types of analyses used. Chapter 0 presents the results of the case study. Finally, chapter 4 summarizes the findings and addresses the applicability to Wrangell, the Tongass, and the USFS agency-wide.

1.1 Background

Established in 1907, the Tongass National Forest (further referenced as the Tongass), contains 16.8 million acres of glaciers, forests, and estuaries in Southeast Alaska stretching from Yakutat Bay in the north to Dixon Entrance in the south. The maritime climate resulting from warmer Pacific currents maintains a temperate rainforest with annual rainfall ranging from 66 cm in the drier regions to 533 cm in the wetter areas (Albert &

Schoen, 2007). Often lauded as the largest remaining temperate rainforest in the world, the primary point of contention in management of the Tongass revolves around old-growth timber stands[1] (Albert & Schoen, 2013). These old-growth stands support biological diversity by providing habitat to many bird, fish, and mammal species including bald eagles (*Haliaeetus leucocephalus alascanus*), five species of Pacific salmon (*Oncorhynchus* spp.), pine martens (*Martes americana*), Alexander Archipelago wolves (*Canis lupis ligoni*), and flying squirrels (*Glaucomys sabrinus*) (Albert & Schoen, 2013). Conversely, old-growth stands and old-growth trees were historically targeted for timber harvesting, a practice referred to as "high-grading". Economics fueled high-grading: The best graded logs grew in the most accessible areas, allowing loggers to maximize their utility. The overlap of ecological needs with conflicting economic uses in old-growth stands has led to increasingly unsatisfactory situations for all stakeholders involved (Beier, 2011; Duran, 2011; Hardigg, 2011; Nie, 2006).

1.1.1 Historical Resource Management

With the establishment of the Tongass as a forest reserve during territorial days, logging eventually became a significant industry when Alaska gained statehood. While small scale commercial logging occurred in the early half of the century, the industry was spread between many hand loggers and small mills which provided mostly cants for mineral mining or crates for fish canneries. Technology, politics, and social changes increased timber supply and demand on the Tongass quickly. Harvesting increased with the advent of the electric and gasoline powered chainsaws; both world wars created a demand for airplane grade logs; and post-war housing booms increased national demand for sawlogs (Rakestraw, 1981). In the 1940's, USFS officials and Alaska territorial politicians sought to open up stands of sawtimber and provide year-round employment through the utilization of pulp wood. With these goals in mind, starting in 1947, the USFS entered into two long-term contracts with pulp mills in the southeast Alaska region. From 1954 to 1997, over

[1] Old-growth is often not defined as individual tree age but by the gestalt of stand conditions: a multi-layered canopy dominated by late-successional trees, patchy understory with downed woody debris, and standing dead snags (Alaback, 1982; USDA Forest Service, 2008).

400,000 acres were logged on Tongass National Forest lands alone (Alexander, Henderson, & Coleman, 2010) and annual production peaked at 600 MMBF in 1973, as shown in Figure 1 (Brackley, Haynes, & Alexander, 2009).

Figure 1. Timber harvest on the Tongass from 1910 to 2012. Source: USDA Forest Service (2013).

Starting in the mid-1970's, changes in social attitudes, global markets, timber economics, and political directives contributed to a decrease in timber production. Decades of emphasis on timber production combined with poor logging practices resulted in the degradation of natural resources on a landscape scale, causing erosion, habitat fragmentation, decreased wildlife and fish populations, and changes in stand compositions (Julian & Shaw, 1999). Increased awareness of logging activities and the shifting attitudes of the national conscious towards more biocentric forest management objectives (Bengston, 1994) led to the creation of the National Forest Management Act in 1976. This act reduced harvest unit sizes and limited timber-sale contracts to 10 years, although the two Alaska pulp mills were grandfathered in. Similarly, in 1980,the Alaska National Interest Lands Conservation Act (ANILCA) set aside 5.4 million acres of the Tongass for conservation management, but included a harvest mandate of 4.5 BBF per decade and an annual subsidy of $40 million for timber related operations to the USFS (Hardigg, 2011). The Tongass Timber Reform Act of

1990 (TTRA) removed the ANILCA board foot mandate and the annual appropriation, while also reducing the available timber lands for harvest and increasing stumpage prices (Nie, 2006). Antiquated pulp mill infrastructure was unable to cope with the pollution and safety requirements that had been put into law during the decades the mill operated. Implementing such regulations required millions of dollars of retrofitting to meet standards (Durbin, 1999). These social and political changes were shadowed by changes in timber economics: demand for wood pulp decreased globally, while softwood plantations in other parts of the globe provided more uniform product on a higher rotation closer to markets, thereby reducing production costs (Brackley et al., 2009).

With the last significant peak in the mid-1990's, timber production on the Tongass plummeted. Further complications arose during the first decade of the twenty-first century, when the Roadless Area Conservation Rule of 2001 designated 9.5 million acres of the Tongass as off-limits to further road development; roads being the primary mode for accessing remote timber harvest units. Initially exempt from the Roadless Rule, years of protracted litigation left the status of the Tongass's exemption equivocal, affecting the ability of resource managers to effectively plan for future timber sales. The final ruling came in 2011, when the Tongass's inclusion under the Roadless Rule was solidified by the Alaska District Court (Organized Village of Kake, et. al. vs. USDA, et. al., 2011). Such inventoried roadless areas are now often managed as de facto wilderness.

In the wake of these events, human and built capital within some of the affected communities declined in the form of unemployment and out-migration during the first decade of the twenty-first century, as management decisions were hindered by uncertainty stemming from the USFS institutional climate (Mackovjak, 2010). With a regional economy reliant upon "fish and chips" (i.e., canneries and pulp mills), employment directly related to timber industries[2] from 1990 to 2009 dropped from 3,463 to 238 (Juneau Economic Development Council, 2011a). From 2000 to 2009, Southeast Alaska saw an increase of

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[2] Timber industries are defined as saw mills, pulp mills, and logging operations.

27% in unemployment, a decrease of 8.7% in population, and a decrease in school enrollment by 17% (Juneau Economic Development Council, 2011b).

1.1.2 Current Situation

In 2010, the U.S. Department of Agriculture recognized the limiting economic, social, and ecological conditions of the current situation on the Tongass and crafted the USDA Investment Strategy for Southeast Alaska (2011). Coined the "Transition Framework", the strategy seeks to adjust the current socio-ecological system through shifts in forest policies and cooperation with other federal agencies and partners. The framework identifies four priority issues: renewable energy, ocean products, visitor services, and forest products.

Along with the Transition Framework, agency-wide initiatives exist to support both restoration efforts and stewardship contracts. Restoration is the practice of using silvicultural tools to improve the complexity, diversity, and functionality of previously degraded ecosystems. Authorized by Congress in 2003, stewardship contracting was established to meet the economic needs of local communities and improve forest health while also promoting collaboration between the communities and land managers. Stewardship contracting allows managers to exchange the timber harvested for services performed, such as road maintenance work or precommercial thinnings, and can be used to keep timber harvest revenue at a local level.

This Transition Framework moves the Tongass out of the rigidity trap described by Beier, Lovecraft, and Chapin (2009), and into the reorganization phase by 1) increasing resilience to perturbations in economics by diversifying community livelihoods, 2) moving the USFS institution out of a mindset of "getting the cut out" and into one that may allow for more win-win situations such as collaboration or adaptive management, and 3) retaining human and built capital on the forest. Combined with the restoration directive and stewardship contract initiatives, the Transition Framework can maintain the ecological capabilities of the forest as well as provide sustainable livelihoods for the communities of Southeast Alaska.

To fulfill the objectives of the Transition framework while also adhering to the TTRA provision of 1) meeting the annual demand for timber and 2) meeting the market demand for the planning cycle, Undersecretary of the USDA directed the USFS to offer four ten-year sales to sustain the timber industry as the region transitions to young-growth (U.S. Department of Agriculture, 2008). One such bridge timber sale is proposed on the Wrangell Ranger District, where this case study takes place. While most stakeholders agree that a transition is necessary, currently one polemic issue on the forest today concerns these proposed ten-year timber sales that bridge the gap between the current system and the desired system. Much of the conflict lies in how much old-growth is available for timber harvesting compared to how much has already been cut. Although the USFS often quotes the allowable cut as less than 3% of the total forest acreage, conservation groups counter that of the remaining timber volume left, less than half of 1% is made up of old-growth forests (Myers, Walker, Kirchhoff, & Schoen, 2011).

These types of inherent clashes over differing land management ethics often stymie the public planning process initially established through the National Environmental Policy Act (NEPA). Through the policies put in place by NEPA, the federal government is required to report those actions on public lands which may have significant impacts to the public and develop alternatives to the actions proposed. One example of such a compliance report is an environmental impact statement (EIS), which is required for those actions which are deemed to have the largest impact, such as large-scale timber harvests. While NEPA established the right of the public to be informed of significant actions and involved with scoping comments, this is not enough to avoid appeals and litigation after an EIS alternative has been chosen and formalized in the Record of Decision (ROD). Since 1991, almost half of the Tongass EIS appeals have gone on to be litigated, and it is estimated that over 75% of expenditures for Tongass timber sales currently go into NEPA planning, appeals and litigation (Beier, 2011). As of February 2012, of the 172 MMBF cleared for harvest under NEPA, over 109 MMBF were under litigation (USDA Forest Service, 2012a). Use of post-ROD litigation by conservation groups as a tool to prevent logging, while effective, hinders the adaptive capacity of the USFS institution, prevents a priori cooperation, and fosters mistrust between the agency and stakeholders (Beier, 2011; Nie, 2006).

One solution to this atmosphere of mistrust is to increase collaboration and transparency prior to the release of a draft EIS. While public scoping comments already provide input during the planning process, these comments often lack spatially explicit information important to site-specific projects. As stakeholders come to the table, the application of public participatory geographic information systems (PPGIS) provides an understanding of the public's attitudes, preferences, and values for forest uses on a spatial scale. Although PPGIS can't remove the social conflict inherent between differing forest values, PPGIS can help to identify areas of conflicting or agreeing forest values (Brown & Donovan, 2013). PPGIS also allows those communities most affected by the transformation to assess their capacity for adapting to such change by first providing individual knowledge of resources and then assessing how ground conditions compare to the community's current human and social capital (Brown & Reed, 2009).

1.2 Values and PPGIS

Couched in the theory of cognitive hierarchy, by understanding human values, researchers can predict attitudes and norms, which can in turn be used to predict behavior (Vaske & Donnelly, 1999). By applying the framework of the cognitive hierarchy theory to forest values on a spatial plane, managers can better grasp the complex values, attitudes, and preferences of various stakeholder groups. This knowledge can inform management decisions, resolve conflicts in resource allocation, increase institutional transparency, and improve external relations.

1.2.1 <u>Values</u>

Values are categorized as either held values or assigned values. Held values are often associated with enduring modes of conduct or end-states (Brown, 1984) and within the realm of natural resources management, held values are defined as those "specific modes of conduct or guiding principles that influence our choices and actions and that are relatively enduring" (Seymour, Curtis, Pannell, Allan, & Roberts, 2010). Because humans are the ones choosing or preferring these values, it is important to point out that values are a human construct (Brown, 1984). In other words, some held values are a means to an end while some held values are the end themselves. For example, generosity would be seen as a means while equality could be viewed as the end state. Held values are often considered conceptual and an idealized preference. They are usually categorized into either instrumental and terminal (Brown, 1984) or instrumental and intrinsic (Bengston, 1994). Assigned values are those values given to an object relative to other objects. When individuals talk about assigning value to something, a contextual preference is expressed. An example might be that while a person may like both hiking and kayaking, she might prefer hiking over kayaking. Thus she assigns a greater value to hiking.

One way of thinking of the difference between held values and assigned values comes from Manfredo (2008) who makes the distinction between "value" as a noun (as in "a person's values determine their attitudes towards trees") and "value" as a verb (as in "to value trees"). Held values influence assigned values through relationships and preferences. A person's assigned value is relative to that object, other relevant objects, their held values and preferences, and the context of the situation (Brown, 1984). Assigned values relate to specific places, and are considered to be better predictors of behavior. Essentially, assigned values are spatially unique and place-based, serving as a proxy for sense of place, which is defined as the connection humans have to their surrounding environment (Brown & Reed, 2000; Brown, Reed, & Harris, 2002; Cheng, Kruger, & Daniels, 2003; Seymour et al., 2010).

1.2.2 Attitudes

Attitudes have been defined as the evaluative action of a person upon an object or entity (Vaske, 2008). Attitudes are comprised of three components: behavioral, cognitive, and affective. The affective is the emotional side of an attitude (e.g., “I like trees.”); the behavioral is the intention of the attitude (e.g., “I don't want to cut down trees.”); and the cognitive is the awareness of the attitude (e.g., “Trees are important for animals.”). Two types of attitudes can be measured by researchers: those which are explicit, meaning that the individual exhibits these attitudes outwardly and has the ability to reflect upon these attitudes, and those attitudes which are implicit, meaning that an individual is unaware of these attitudes or is constrained by social norms to repress exhibition of these attitudes

(Oskamp & Schultz, 2004). Because explicit attitudes are often the easiest to measure through self-reporting, the vast majority of research has been on these types of attitudes.

The difference between values and attitudes is not one of linguistic semantics. Firstly, researchers designing studies need to know which concept they are interested in, so as to understand what methodology to use to measure a construct (such as explicit value measurement methods like surveys). They also need to understand what their findings can and cannot be applied towards. This ties to the second important difference: the psychological theories behind attitudes and values differ. Values are often referred to as enduring while attitudes may be dependent upon the situation or object. The magnitude of a person's attitude differs given the situation, while values are strongly held. Because values are more stable, they influence attitudes. People within certain groups may share their values, but their prioritization of these values differs, which is what makes this system of prioritization an attitude (Vaske, 2008). There is also the question of how attitudes and values come to be impressed upon a person: are these concepts inherited or do they slowly grow with time? Knowing the theories behind each of these concepts and applying these theories is vital to natural resource management. Studying held values with the intention that the resulting information will assist managers in changing people's attitudes has no applicability without knowing *how* the held values influence the attitudes in the first place (Manfredo, 2008).

Understanding attitudes helps establish management objectives on a project and plan level, helps predict the public's reaction to management decisions, and can resolve conflict (Bengston, 1994). Similarly, understanding public attitudes may predict consumer behavior and political action (McFarlane & Boxall, 2000). While understanding attitudes and beliefs may not eliminate conflict, it does assist in planning efforts. For example, knowledge of Anchorage residents' attitudes towards moose hunting in the Anchorage bowl allowed managers to identify research needs, goals for the design of the hunt, and outreach efforts which address the conflicting beliefs and evaluations underlying the residents' attitudes (Whittaker et al., 2001). Attitudes also allow managers to know where they should put their efforts – it is more difficult to change values than to it is to change attitudes.

There are three or four moderator variables attributable to when attitudes and values will predict behavior: the attitude, the person, the situation, and the outcome of the behavior itself (Ajzen & Fishbein, 1980; Oskamp & Schultz, 2004). Firstly, the origin, strength and specificity of the attitude itself will influence how strongly it predicts behavior. The origin of the attitude deals with saliency and how prominent the attitude is in the forefront of the person's mind. Also influencing the strength of the attitude are other factors such as knowledge about the topic, how the topic affects a person, whether or not the topic is the basis of the person's identity, and how accessible a topic is to the person. Specificity on an attitude includes knowing the actions taken, the target of the actions, the time of the actions and the context of the actions. In summary, attitudes have a lower predictive validity when they ignore specificity, salience, and attitude strength (Manfredo, 2008).

Many cognitive models have been used to explain the relationships between values, value orientations, beliefs, held values, assigned values, norms, attitudes, and behavior, all with variations of the most important antecedent factors (e.g., age, gender, education, and livelihood). Perhaps the most applied framework for measuring attitudes is based on the Theory of Reasoned Action (Ajzen & Fishbein, 1980). This theory is predicated upon the concept that by knowing a person's attitudes and beliefs, one can predict their behavioral intentions, which in turn predicts their behavior. The behavioral intention is a function of the person's attitude towards the behavior and the subjective norms about the behavior. Again, prediction of behaviors is reliant upon the origin, strength, and specificity of the attitude.

Another framework for measuring attitudes builds upon the Theory of Reasoned Action, and is named the Theory of Planned Behavior. Simply put, this theory adds the variable of perceived control to the model for predicting behavior. That is, how much control a person believes they have over the outcome of a situation will influence their behavior (Ajzen, 1991). Of relevance to this case study is the Cognitive Hierarchy Model which suggests that held values affect specific attitudes which in turn affect specific behavior (Rokeach, 1973). Expanding on this socio-psychological theory, Seymour et al. (2010) included an assigned values component relevant to natural resources management. Figure 2 shows the adapted model used in this case study.

Of note, throughout the natural resources management social science literature, while the term "value" is often defined consistently with the Rokeach (1973) definition as "an enduring belief that a specific mode of conduct or end state is preferable to others," many other authors do not take into account the differences between held and assigned values.

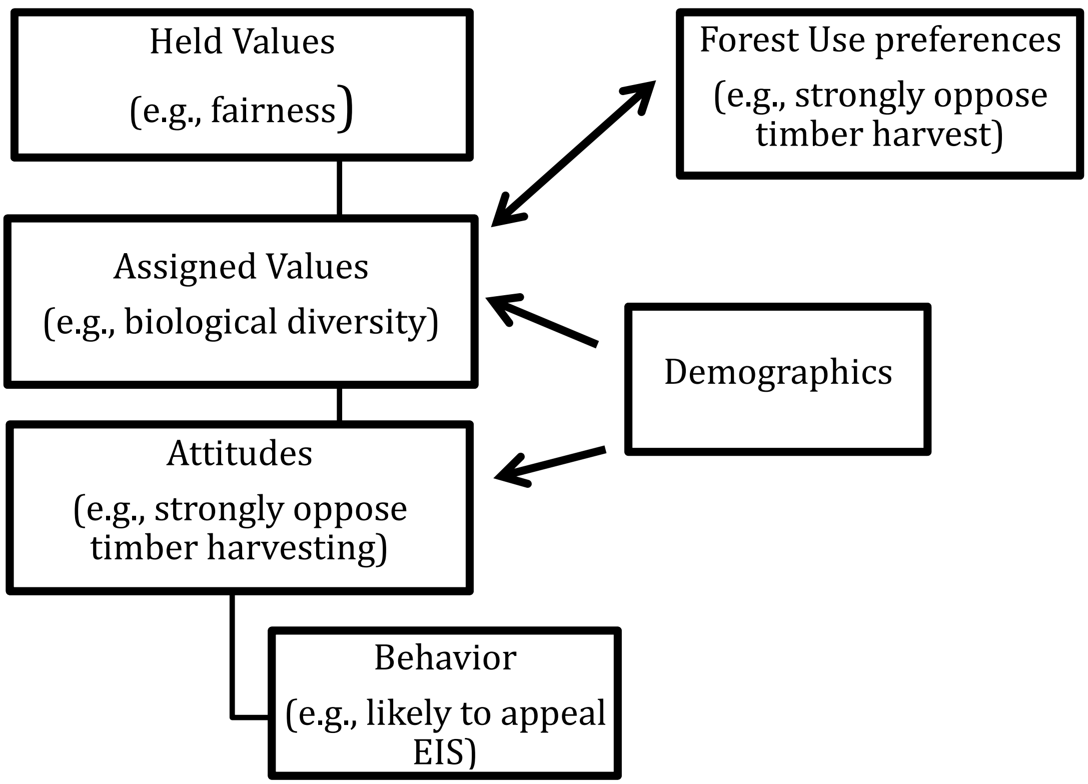

Figure 2. Cognitive Hierarchy Model, adapted from McFarlane and Boxall (2000) and Seymour et al. (2010).

1.2.3 Landscape Values

Within forest management on public lands, the greatest amount of research conducted has been focused on the changes in the public's held values since the early 1990's. Changes in held values (both instrumental and intrinsic) were also mirrored by managers within the USFS as workplaces began diversifying and management directives shifted to what is now called ecosystem management (Bengston, 1994). Within this context of shifting paradigms, many philosophers and researchers began calling for identification of, and accounting for, held values not previously recognized by public land managers (Rolston & Coufal, 1991). A handful of researchers have followed up on this call to action for further investigating public forest values (Manning, Valliere, & Minteer, 1999; McFarlane & Boxall, 2000; Schaaf, Ross-Davis, & Broussard, 2006; Tarrant, Cordell, & Green, 2003) with the majority of the research regarding held forest values based on the typology originally suggested by Rolston and Coufal (1991).

Brown and Reed (2000) were the first to posit that held forest values and attitudes towards forest management issues were predictably linked through assigned values. To measure the relationships between held values and attitudes on a geographic level, the branch of landscape values was developed. Defined as "values that humans place on goods and services in a spatial context" (Brown et al., 2002), landscape values were called social, environmental, ecosystem, or wilderness values in the nascent stages of research. Throughout the rest of this paper, spatially assigned forest values will be referred to as landscape values. Landscape values have also been defined as filling in the geographic gap left by sense of place, and serve to identify intangible cultural services as well as explore the relationships between held values, attitudes towards forest management, and demographics (Brown & Raymond, 2007; Chan et al., 2012; Raymond et al., 2009; Seymour et al., 2010).

When stakeholders themselves use geographic information systems (GIS) to assist in land planning efforts, this is defined as "public participation geographic information systems" and in democratic countries often refers to local participants using GIS in place-based mapping with the end goal of providing input towards management decisions concerning public arenas (Pocewicz, Nielsen-Pincus, Brown, & Schnitzer, 2012). Community participation is a key objective in NEPA planning and as such, landscape values have been applied to national forest planning in Alaska (Brown & Donovan, 2014; Brown et al., 2002), Oregon (Brown & Reed, 2009), California (Brown, 2013), Colorado, and Wyoming (Clement & Cheng, 2011). The USFS planning rule passed in 2012 encourages the use of PPGIS methods for forest planning through "use of contemporary tools, such as the Internet, to engage the public…" (Federal Register, 9 April 2012) and the USDA has formally requested to use PPGIS for 15 national forests plans (Federal Register, 2 April 2010).

1.2.4 Forest Uses

Recently, in addition to understanding relationships between attitudes to forest management activities and landscape values, researchers have begun to explore the relationship between values and forest use preferences (Brown, 2013; Brown & Donovan, 2013). Forest use preferences are defined as a respondent's cognitive preference for an activity taking place on public forest lands, such as site-seeing or timber harvesting. Because mapping of landscape values may not be enough to inform the public planning process, spatially identifying acceptable and unacceptable forest uses brings the "what?" question of forest management into clearer focus than mapping landscape values alone. Within the context of this paper, mapped forest uses preferences are simply referred to as spatial forest uses. Relationships have been found to exist between spatial forest uses and landscape values in a cognitive sense – the total count of spatial forest uses is related to the total count of landscape values. Spatial correlations have also been found to exist between use preferences expressed in surveys and landscape values expressed on maps.

Knowledge of values, uses, and attitudes usually comes in the form of well-established NEPA comments during scoping periods. Yet, conflicts still arise with this nebulous format. Utilizing landscape values and use preferences pinpoints the actual areas of conflict and allows managers to focus the discussion on these areas during EIS alternative development.

To date, no known studies have sought to geospatially assess landscape values on the Tongass National Forest, although this need has been formally identified, especially in relation to ecosystem services (Patterson et al., 2012). PPGIS on National Forests in the lower 48 often focus on issues irrelevant to the Tongass, such as wildfire risk. Research has been conducted on the only other federal forest in Alaska, the Chugach National Forest, but the issues facing both forests are vastly different. Since the current state of community landscape values on the Tongass lacks documentation, navigating the system's transformation will prove difficult to managers and communities seeking to establish and prioritize their desired objectives. Using PPGIS to recognize areas of conflicting landscape values will help managers and communities actively guide the transformation. These social values also serve to nurture trust between the agency and the communities, tearing down some of the institutional barriers that prevent agency transformation.

1.3 Objectives

This case study intends to bring together social science, forestry, and geographic information system (GIS) methods to help forest managers design a NEPA EIS alternative for a ten-year timber sale on the Tongass. This goal will be achieved by objectives that 1) determine what, if any, volume harvest ceilings are acceptable to local community members and 2) that avoid areas of conflicting uses and values that still provide for a viable timber harvest. To address these goals, this study will research landscape values and forest uses identified through PPGIS in Wrangell, Alaska. Specifically, the study will answer the following questions:

- Do social or demographic differences exist between respondents with different attitudes towards Wrangell Island EIS volume harvest alternatives? Do social or demographic differences exist between respondents with different preferences towards landscape values and spatial forest uses?
- Does a relationship exist between forest use preferences and the frequency of landscape values mapped? Does a relationship exist between forest use preferences and the frequency of spatial forest uses mapped?
- Does a relationship exist between attitudes towards Wrangell Island EIS volume harvest alternatives and the frequency of the landscape values and forest uses mapped?
- Does a relationship exist between landscape values and spatial timber harvest uses? Are these relationships simply cognitive, meaning only expressed with the total number of values or uses mapped? Or are these relationships spatial, meaning clustered on variable map scales?
- Does a relationship exist between points mapped as acceptable and points mapped as unacceptable for timber harvest use?

While this site-specific study informs the Wrangell Island EIS, helping managers place values spatially, the broader outcomes of the study will be applicable Tongass-wide during the transition by increasing government institutional transparency and increasing public input. On a national level, the purpose of this work seeks to address conflicting values and uses in the public planning process applicable to any land management decisions. Lastly, this study further validates the theoretical relationships between landscape values and attitudes, as well as forest use preferences and spatial forest uses.

2. METHODS

2.1 Study Location and Background

This study addresses landscape values and forest uses on the Wrangell Ranger District (WRD) within the Tongass (Figure 3). Located in Southeast Alaska, the Tongass extends from latitudes 55 degrees North to 60 degrees North and encompasses almost 17 million acres of land along the Alexander Archipelago. The Wrangell Ranger District lies in the southern half of the forest, and contains 1.7 million acres of USFS land.

Wrangell Island houses the oldest continuous logging operation in the southeast region, at one time claiming title as "The Lumber Capital of Alaska" (Mackovjak, 2010). In 1954, a sawmill was constructed at Shoemaker Bay to support a 3 BBF contract, which was eventually reduced to 693 MMBF over the course of 15-years (Harris & Farr, 1974). Still, the sawmill at Shoemaker Bay continued to produce roughly 4.5 BBF of lumber over the course of 40 years and was the largest and longest running sawmill operated in Southeast Alaska (Roppel, 2011). Due to the changes wrought in timber supply by the TTRA of 1990, the mill first closed in 1995, and then operated intermittently until being permanently closed and dismantled in 2010.

During the decade after the initial closure of the mill, Wrangell's population dropped by 16%, and school enrollment dropped by 36% while unemployment increased by 3% (Juneau Economic Development Council, 2011b). Within the boundaries of the district, substantial timber harvest has occurred on roughly 43,000 acres of managed stands on federal lands alone and on over 2,000 acres of private or state lands (USDA Forest Service, 2012b). With both substantial impacts to the socio-economic and the ecological systems, the socio-ecological system of Wrangell is still sensitive to transformation and would benefit from increasing resiliency to undesirable external change.

Wrangell citizens are now actively seeking ways to restore their economy, community, and surrounding lands. With the definitive closure of the mill in 2010, the City and Borough of Wrangell has actively pursued private interests to revive a medium-sized timber industry in Wrangell (Sheinberg Associates, 2010). Along with the other components of the USDA

Transition Framework, forest products factor heavily into the management objectives for Wrangell in order to retain human capital vital to the transition to young-growth logging. Therefore, in 2008, Wrangell Island was chosen as a prime candidate for a “bridge” ten-year timber sale to support the then still-running sawmill. Although the Wrangell mill closed in 2011, plans to build a medium-sized mill in Petersburg still provide a demand for round logs from the Wrangell Ranger District (Lichtenstein, 2013). As well, two small-scale, value-added mill operators are still housed on Wrangell Island, consuming roughly 2 MMBF of timber per year.

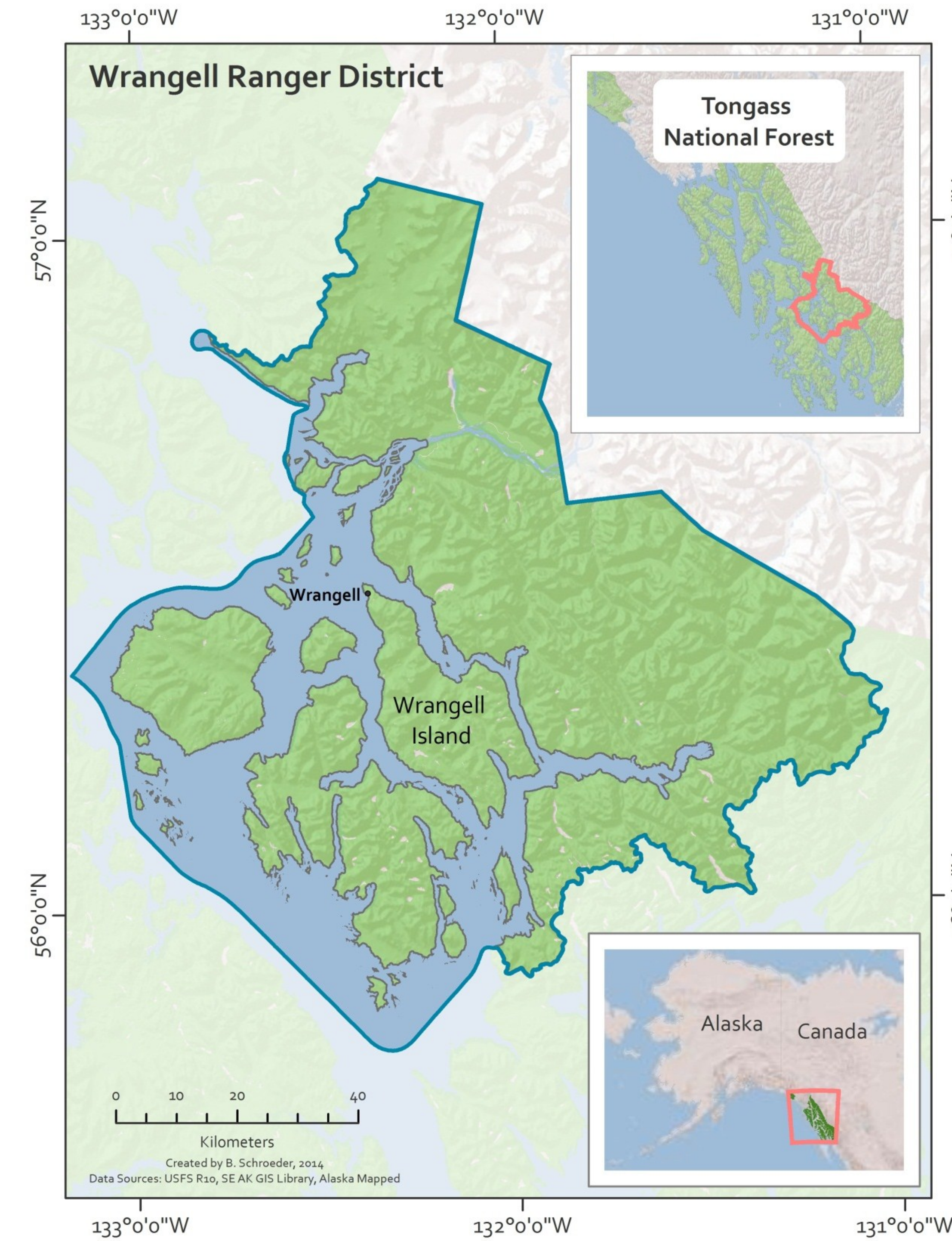

Figure 3. Study Area, Wrangell Ranger District, Tongass National Forest, Alaska

In preparation for this timber sale, the USFS is currently complying with National Environmental Policy Act (NEPA) requirements to produce the Wrangell Island Environmental Impact Statement (EIS). Currently, the Wrangell Island EIS seeks to "provide a reliable, long-term supply of timber that will support local jobs and facilitate the transition to a sustainable wood product industry based on young-growth management," (Federal Register, 1 August 2013). To date, in the Notice of Intent (NOI), three issues for the Wrangell Island EIS have been identified: 1) timber supply and timber sale economics, 2) old-growth reserves, and 3) road construction and road access. This EIS considers alternatives which offer up to 100 million board feet (MMBF) in timber sales over the course of 10-years, a timeline limited by the codified National Forest Management Act in 1976 (Federal Register, 7 December 1990). Although initially the purpose of limiting the length of contracts was to avoid the type of pressure caused by the two pulp mills' 50-year contracts (Mackovjak, 2010), receiving a contract extension is possible with a signature from the Chief of the USFS (USDA Forest Service, 2011).

Once the Wrangell Island EIS has been finalized, the following timber sale contracts have the potential to identify stewardship projects and restoration work on the district that would not only increase community capacity but could also address serious ecological concerns on USFS lands. As USFS managers draft alternatives to the EIS, public participation and identification of forest use preferences during the scoping periods are essential to prioritizing management objectives. Documentation of the relative economic and social values derived from the forest is also necessary, so as to better understand how managerial tools like restoration work and stewardship contracts can assist in increasing community capacity. Similarly, with limited funding, forest management objectives must be prioritized by assessing the ecosystem services provided by the forest in relation to the social systems within the forest.

2.2 Data Collection

To identify community members' landscape values on the Wrangell Ranger District, as well as their attitudes and preferences towards management activities on the Tongass, internet and paper surveys were conducted in the community of Wrangell during spring 2013

(Table 1 shows the survey implementation timeline). Because the planning process for the USFS during NEPA projects is political in nature, the sampling frame for the PPGIS only included citizens of Wrangell registered to vote within the City and Borough limits of Wrangell. Registered voter data was purchased from the State of Alaska Division of Elections in December 2012 with N=1,649 (State of Alaska, 2012). To ensure internal study validity, the sample selection for this study was a simple random sample of only those residents with mailing addresses in Wrangell (i.e., not including Meyers Chuck). To ensure representation of Wrangell residents, a 50/50 response split over the most controversial issues was assumed with a confidence interval of 95% with +/- 5% error. To obtain a sample size large enough to represent the population of Wrangell, 304 completed surveys were needed (Vaske, 2008, p. 181). About twice the amount of surveys needed were sent out (n = 700) to ensure that the required number of surveys (n=304) was obtained. Most participatory paper mapping surveys on average yield 30% response rates, with internet mapping surveys on average yielding 13% response rates (Pocewicz et al., 2012). Assuming the survey was conducted solely with internet methods with a response rate of 13% , to receive at least 304 completed internet surveys the entire population of voters (N=1,649) would need to receive invitations to participate in the internet surveys (Vaske, 2008, p. 209). Yet, surveying the entire population would be cost prohibitive and would defeat the purpose of sampling. Another drawback to internet surveys is the potential introduction of bias since the method requires technological literacy and access to internet (Pocewicz et al., 2012). Although 85% of Wrangell households have the ability to access internet through DSL, cable, or wireless broadband, not all who have access subscribe to internet services (Connect Alaska, 2012). Still, internet mapping provides a higher level of accuracy, increased precision, and reduced data processing costs (Brown & Kyttä, 2014). Therefore, due to budget constraints and the trade-offs associated with each type of method, the survey consisted of mixed methods, with the option to respond either by internet or by paper.

Questions on the surveys were based on those surveys conducted by Brown (2004); Clement and Cheng (2011), and Pocewicz et al. (2012) and are included in Appendix A. The measurement validity of this framework was first tested by Brown and Reed (2000). The first section of the survey asked questions about the respondent's familiarity with and interest in forest management activities. The second section asked questions on a Likert scale about forest use preferences. The third section asked questions to gauge attitudes towards Tongass Transition issues and issues noted in the Wrangell Island EIS Notice of Intent. Section 4 provided guidance for the paper mapping exercise (if applicable). Section 5 asked demographic questions about residency, age, gender, and education. The study was exempted by the UAF Institutional Review Board under Project 378869-1.

To test the content validity of the study, in constructing the survey, expert advice was sought from key individuals such as the interdisciplinary team leader for the Wrangell Island EIS, members of two regional conservation groups, the WRD recreation and timber staff, and Wrangell city employees. After incorporating the suggestions from the expert panel, a pretest was conducted with five individuals representative of the Wrangell community. Errors were identified after one last proof-reading (Vaske, 2008, p. 174).

The paper surveys included an 8-page survey with a separate cover letter and a 17 by 22 inch map with a 1:800,000 scale. Three (3) labeled sticker sheets were included: one sticker sheet contained thirteen (13) values with five (5) stickers for each category, one sticker sheet contained thirteen (13) acceptable uses with five (5) stickers for each category, and one sheet with thirteen (13) unacceptable uses with five (5) stickers for each category (the list of values and uses is shown in Figure 4; see Appendix A for value and use definitions). All totaled, paper survey respondents could only map a maximum of 195 points. With the paper version, each 0.5 cm sticker represented 1.9 kilometers on the ground.

Values	Acceptable and Unacceptable Uses
•Aesthetic	•Helicopter timber harvest
•Biological	•Ground-based timber harvest
•Cultural	•Roads
•Economic	•Subsistence lifeways
•Future	•Recreational facilities
•Historic	•Motorized use
•Intrinsic	•Non-motorized use
•Learning	•Old-growth reserves
•Life-sustaining	•Commercial tourism
•Recreation	•Scenic viewshed
•Spiritual	•Energy development
•Subsistence	•Wilderness or wild/scenic river
•Therapeutic	•Other development

Figure 4. Types of values and uses included in the mapping exercise

Those who chose to complete the survey through the internet were directed to a log-in page, and from there an informed consent page. After electronically signing the informed consent, the participants first accessed a webpage with a Google Maps application programming interface which allowed respondents to view all of the Wrangell Ranger District with a zoom function down to a scale of 1:9,000. The default view set the map scale at 1 cm representing 5 km on the ground, though points could only be mapped starting at a scale of 1:18,000. The Google Maps interface allowed viewers to turn on and off base layers (satellite, terrain, or a hybrid of the two) as well as a recreation sites layer. Internet maps provided respondents with the same types of values and uses as the paper maps, though internet users could place an indefinite amount of markers. These markers were "dragged and dropped" onto the map to represent the values/uses. After mapping a minimum of one point, internet users were allowed to continue on to the survey.

In the initial contact of the sampling period, pre-survey postcards were mailed to 700 citizens. This postcard notified participants that they were chosen for the survey and asked them to watch for further instruction in the mail. Within a week, letters were mailed to participants containing an invitation to participate in the study. This letter included instructions for accessing the internet site as well as a unique access code. If two randomly sampled subjects from one household received an invitation letter, both were requested to complete the survey. This invitation letter also included a postage-paid return postcard for those who wished to receive a paper version of the survey or to decline completion of the survey all together (Pocewicz, Schnitzer, & Nielsen-Pincus, 2010). Citizens could also request a code to provide voluntary information. The purpose of allowing voluntary information was to include any and all stakeholders during the public input process, so that this information could be conveyed to the district for further planning projects. These voluntary codes had different three-digit prefixes than those assigned to the random sample. This voluntary information was provided to the district but was removed from the analysis for this study.

Mailings were based on survey designs established by Dillman (1991). After the initial invitation, a follow-up mailing two weeks later was sent to those who had not yet responded. Four weeks after the initial invitation, a second follow-up mailing was distributed. A third and final mailing was sent two weeks after the second follow-up mailing, again encouraging participation with a drawing for $300 gift card to the local grocery store/mercantile (Brown & Weber, 2012). This third mailing sent 30 randomly selected non-response participants a paper survey to test the viability of the mixed methods (Pocewicz et al., 2012). Finally, three weeks after the third follow-up mailing, 120 random paper surveys were sent in an attempt to increase response rates.

Along with the targeted mailings, all residents of Wrangell were made aware of the research through various community resources including articles in the newspaper, the radio station's community calendar, and postings at the library, town hall, grocery stores, post office, USFS office, and the museum. These resources were utilized to notify residents before the survey began, encouraged those who received codes to fill out their surveys, thanked those who did participate, and notified all residents about accessing the research results afterwards.

A non-response test was conducted in June 2013 to assess potential sampling bias. Due to poor data management, this process was repeated in January 2014. During the second test, nineteen randomly selected non-participants were contacted by telephone and asked questions about attitudes, preferences, and demographics. Non-participants were also asked why they had not completed the paper/internet survey.

Table 1. Survey implementation timeline for 2013

Pre-contact postcard	February 7
Initial mailing – SAS postcard for paper	February 19
Follow-up postcard	March 4
Second postcard	March 18
30 random paper samples	April 2
Third postcard[3]	April 1
Corrected third postcard	April 9
120 Random paper sample	April 25

2.3 Analysis

Completed surveys were entered into IBM SPSS© (2010) by hand or through CSV files, and maps were either digitized or loaded though CSV files into ESRI© ArcMap™ (2010). Analysis of landscape values with spatial timber harvest uses was done using the `spatstat` package in the statistical program R (R Core Team, 2013). Factor analyses have been conducted in multiple studies on the thirteen value typology where the thirteen values were found to be mutually exclusive (Brown & Reed, 2000; Clement-Potter, 2006; Pocewicz et al., 2012), so no analysis was conducted to further test the values typology itself. The 13 acceptable and 13 unacceptable uses were not intended to be all inclusive, but were chosen based on relevance to the Transition Framework, the Wrangell Island EIS, or the various other rules

[3] This postcard was sent to 500 residents but contained the wrong log-in code.

and plans affecting the Tongass (e.g., Roadless rule, the Tongass forest plan). Therefore, acceptable and unacceptable uses were not called upon to predict attitudes.

2.3.1 Respondents compared to non-respondents

To ensure internal study validity, those respondents who were not part of the random sample or who were not Wrangell residents were removed, as were mapped points falling outside of the Wrangell Ranger District. To assess sampling bias, non-respondents' demographics were compared to respondents' using chi-square tests, which tested for statistically significant differences between the distribution of the two groups. Next, non-respondent attitudes and preferences were compared to respondents using chi-square tests for use preferences, interest in forest management, attitudes towards old-growth reserves, and attitudes towards attracting medium-size mill operators. To assure the external validity of the survey responses, Wrangell census data from 2010 was compared to demographics reported by survey respondents and, using a chi-square test, the two groups were compared to identify any significant differences.

The workflow for the research project is shown in Figure 5. To meet the final goal of this research project, that being collaboration and compromise, five different research questions were explored: the influence socio-demographic and background variables had on respondents' values and attitudes (Step 1 in Figure 5); the relationship between use preferences and landscape values/uses frequencies (Step 2 in Figure 5); the relationship between timber harvest attitude and landscape value frequencies (Step 3 in Figure 5); the cognitive and spatial relationships between landscape values and spatial timber harvest uses (Step 4 in Figure 5); and the spatial relationship between spatial acceptable timber harvest uses and unacceptable timber harvest uses (Step 5 in Figure 5).

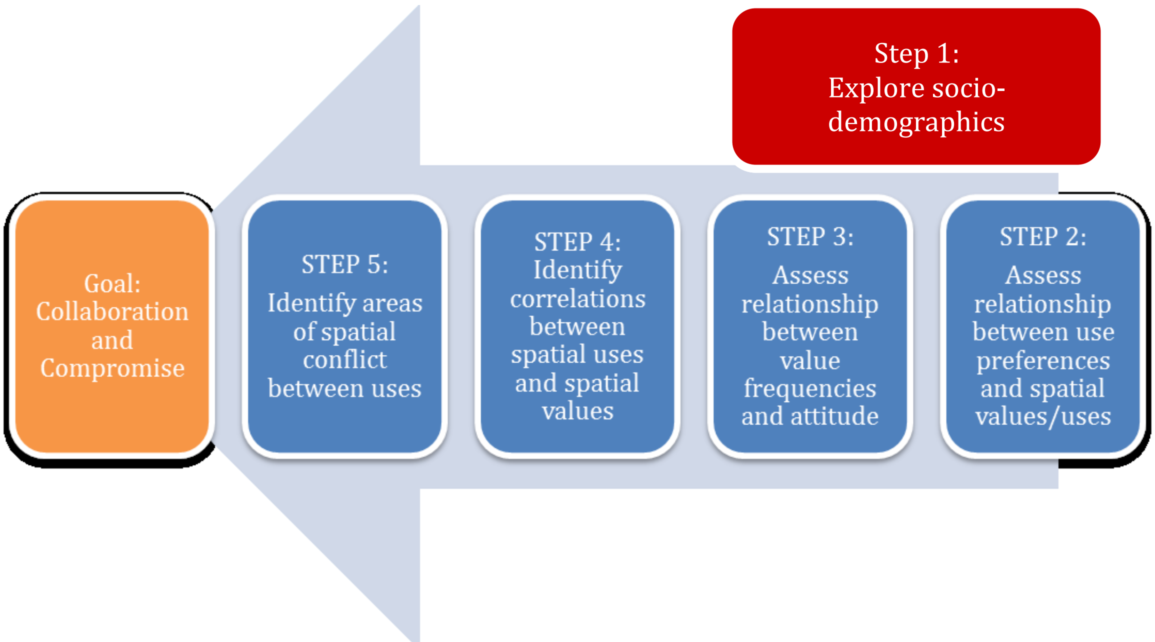

Figure 5. Workflow for research

One question from the survey was chosen to explore the relationships between values, attitudes, landscape values, and spatial use preferences. This question gauged attitudes about Wrangell Island EIS timber harvest alternatives (Appendix A, Section 3, question 18). Respondents were clustered into three groups based on their attitude towards timber harvest: 1) those who favored no timber sales, 2) those who favored an EIS alternative with a 50 MMBF ceiling, and 3) those who favored an EIS alternative with a 100 MMBF ceiling. Frequencies of each category of landscape values and spatial uses were calculated for each individual respondent for gauging relationships between landscape values and other variables.

2.3.2 Socio-demographics

Question 1: Were there socio-demographic differences between respondents with different attitudes towards Wrangell Island EIS volume harvest alternatives? Were there socio-demographic differences between respondents with different preferences towards landscape values and spatial forest uses?

Figure 6. Relationships between demographics and attitudes towards timber harvest

$H1_A$: Attitudes towards Wrangell Island EIS volume harvest alternatives will be significantly different between gender, age, length of Wrangell residency, and survey type used.

Analysis:
A chi-square test was used to assess the significance of a relationship between socio-demographic variables and the attitude towards timber harvest (no timber sales, an alternative timber harvest 50 MMBF, and an alternative timber harvest 100MMBF). Independent variables explored were gender, age, education, length of Wrangell residency, type of survey submitted, whether or not the household earned income from forest products, the respondent's familiarity with the forest, their interest in the forest, and finally their knowledge of the forest.

To assess relationships between these socio-demographic variables and the mean frequency of landscape values and spatial uses mapped, Spearman's product moment correlation was calculated for each of the continuous independent variables (age, percentage of food gathered from forest) , while independent t-tests were used with dichotomous independent variables (gender, survey type, income from forest, Wrangell residency split at 10 years), and one-way analysis of variance was used for all categorical independent variables (education, familiarity with the forest, interest in forest management, knowledge of forest management). Tukey's honestly significant difference test was used to assess cases with homogeneity of variance, otherwise Games-Howell was used if sample variances were not homogeneous and the sample sizes were unequal.

Quite often the data in the Wrangell case study violated the parametric assumption that the data were distributed normally. Therefore more conservative tests were used to estimate the relationships between variables. While Pearson's correlation coefficient can be used to describe relationships for non-parametric data, it is best applied in scenarios involving a continuous variable and interval variable limited to two categories. Because the value frequencies were interval variables with 5 categories each (since respondents could map up to five points for each value/use), Spearman's rho was chosen to provide more conservative estimates based on non-normal distributions (Brown, 2013; Field, 2009; Vaske, 2008). One way analysis of variance (ANOVA) tests, on the other hand, are more robust in the face of non-normal distributions in all but the most extreme cases, and are therefore an adequate test for comparing means between groups (Vaske, 2008). Finally, when sample sizes are greater than 50 respondents (as in the Wrangell case study), the normality assumptions required for t-tests can also be relaxed for non-normal distributions

2.3.3 Use Preferences

Question 2: Does a relationship exist between forest use preferences and the frequency of landscape values mapped? Does a relationship exist between forest use preferences and the frequency of forest uses mapped?

Forest Use Preference	**Strongly Oppose**	**Oppose**	**Neither**	**Favor**	**Strongly Favor**
Timber harvesting	1	2	3	4	5

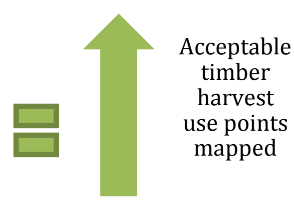

Figure 7. Example of relationship between forest use preferences and value frequencies

H2$_A$: There will be a statistically significant, positive correlation between mean preference scores and landscape values mapped (i.e., spatial economic value frequencies will correlate highly with timber harvesting use preferences). There will be a high, positive correlation between mean preference scores and acceptable uses mapped (i.e., spatial timber harvest use frequencies will correlate highly with timber harvesting use preferences).

Analysis: Frequency of points in previous studies have been highly correlated to respondent assigned point values (r = 0.82 to 0.88) using Spearman's rank correlation coefficient (Brown & Reed, 2009), meaning frequency of points is an appropriate proxy for importance weighting. Spearman's correlation coefficient was used to assess the relationship between values and the mean use preferences scores. As well, Spearman's rho was also used to test the construct validity that cognitive use preferences are correlated with spatial use frequencies.

2.3.4 Attitudes

Question 3: Does a relationship exist between attitudes towards Wrangell Island EIS volume harvest alternatives and the frequency of the values and uses mapped?

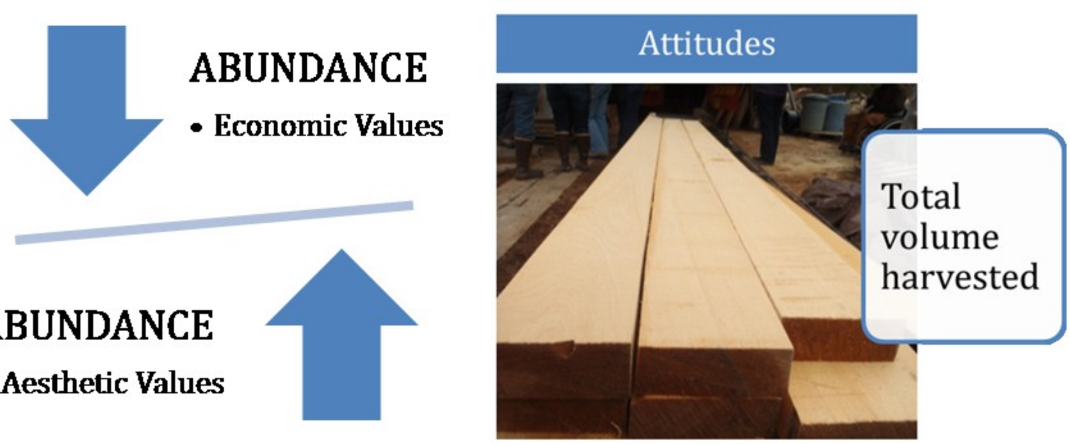

Figure 8. Example of a relationship between attitudes towards timber harvest and value frequencies

$H3_A$:

There will be a positive correlation between economic values and higher timber harvest volume (e.g., respondents who prefer to log higher volume in a shorter time span will map more economic values markers). There will be a positive correlation between acceptable timber harvest uses and higher timber harvest volume (e.g., respondents who prefer to log higher volume in shorter time span will map more acceptable timber harvest use markers).

Analysis:

To test if values predict attitudes towards timber harvest volume proposed for the Wrangell Island EIS, discriminant function analysis was used (Clement-Potter, 2006). The purpose of using discriminant analysis is to group the respondents by their attitudes to a categorical dependent variable (specific EIS question) and a scale independent variable (landscape value frequency). As well, discriminant analysis explains how well the independent variables classify the dependent variables. Lastly, using discriminant function analysis quantifies how much each independent variable causes the dependent variable to vary from the mean.

2.3.5 <u>Landscape Values and Spatial Forest Uses</u>

Question 4: Does a relationship exist between landscape values and spatial timber harvest uses?

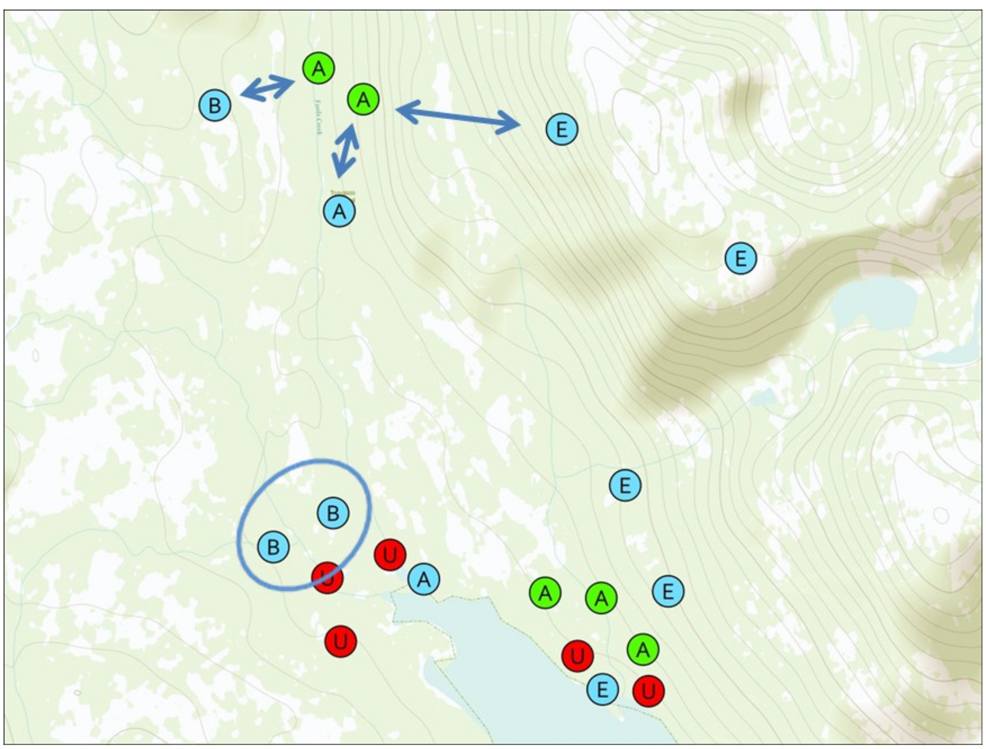

Figure 9. Example of relationships between values and timber harvest uses

$H4_A$: A cognitive relationship will exist between the frequency of landscape values and spatial frequencies – specifically, economic value (and other material value) frequencies will have a high, positive correlation with acceptable timber harvest use frequencies while intrinsic value (and other intangible/non-material value) frequencies will have a high, positive correlation with unacceptable timber harvest use frequencies. Markers of similar values will also exhibit spatial auto-correlation (e.g., biological values will be clustered). Markers of acceptable timber harvest use will be closest to economic (or other material) values. Markers of unacceptable timber harvest use will be closest to intrinsic (or other intangible/non-material) values.

Analysis:

Firstly, the presence of a cognitive relationship was explored by conducting a bivariate Spearman's product moment correlation to compare spatial value frequency to spatial use frequency. Next, spatial relationships for each unique value category were explored by identifying clustering of values at varying scales using the Multi-Distance Spatial Cluster Analysis (Ripley's K-function) in ArcGIS. If values were randomly dispersed, then relationships to other values or uses would be random, and therefore inconsequential for further analysis. To account for possible clustering at different map scales, Ripley's K statistic counted the intensity of points within a specified search radius and compared the observed number of points to the expected number of points at each specified scale. This K statistic was then standardized which allowed comparisons across distances. To reduce the potential of committing a Type II error in hypothesis testing, a Monte Carlo approach ran 999 iterations to create a confidence envelope of $\alpha=0.01$. The Monte Carlo approach generates random points 999 times and calculates K for each iteration. At each distance increment, the highest and lowest K values of those 999 iterations were chosen as the confidence envelope. If the standardized K is above the confidence envelope, then it is assumed that the points cluster at that distance. Finally, to estimate clustering for points near the district boundaries, these points were mirrored outside of the boundary to simulate an outer boundary. The search radius tested 2 km increments up to 20 km (Pocewicz & Nielsen-Pincus, 2013).

The last step in spatial analysis for values and uses was a proportional variant of nearest neighbor analysis. This analysis was used to assess the spatial relationships between acceptable uses and values, as well as unacceptable uses and values (Brown, 2013). Buffers were created around each individual acceptable point at distances of 1, 5, and 10 km. For each value category, the points within each buffer radius were counted and the proportion of points within that buffer was calculated based on the total number of mapped points all value categories. This analysis was repeated for unacceptable timber harvest uses and each value category.

2.3.6 Spatial Forest Use Conflicts

Question 5: Does a relationship exist between points mapped as acceptable and points mapped as unacceptable for timber harvest use?

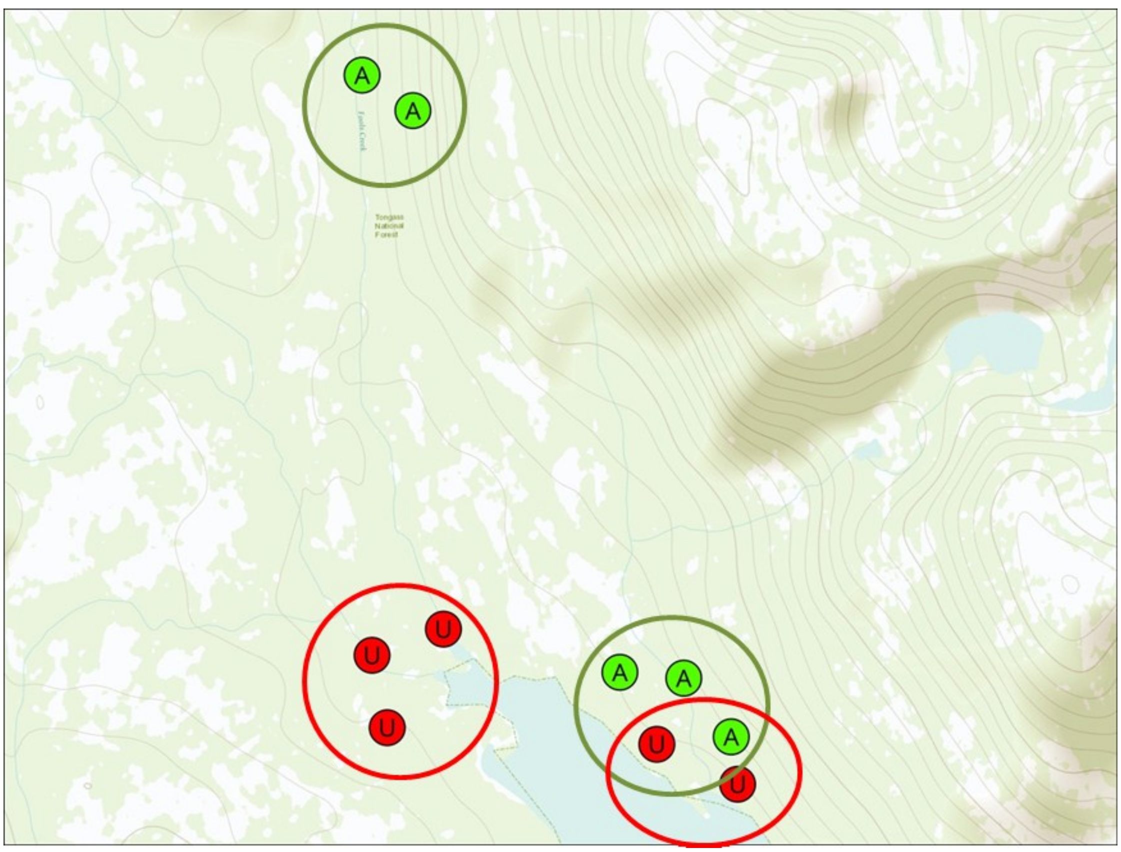

Figure 10. Example of relationships between acceptable and unacceptable timber harvest uses

$H5_A$: Each category of timber harvest use will exhibit spatial autocorrelation. There will be a positive correlation between proximity of both uses. In other words, acceptable and unacceptable timber harvest use areas will cluster and overlap.

Analysis:

Spatial relationships were first explored by testing for clustering at varying spatial scales using the Multi-Distance Spatial Cluster Analysis (Ripley's K-function) similar to that used for assessing clustering for landscape values in the previous analysis. Next, kernel densities were created for both acceptable and unacceptable. The kernel density function is a non-parametric estimator of the cumulative underlying point densities for any given pixel. Kernel density estimates smooth out the densities of aggregated points by applying a kernel function and defining a bandwidth around the kernel. Kernel density is best used in applications when the distribution of a point is continuous instead of discrete and there is uncertainty of the influence of the point on surrounding attributes (Wand & Jones, 1995). For assessing timber harvest uses, a 4 km radius was chosen as the bandwidth, since plots of value proximity plateaued near 4km in Step 4 (Figure 5). The cell size used for the kernel density estimate was 2 km since this was representative of the scale of points on the map. The results of kernel density estimates are sensitive to bandwidths, but previous studies with similar reference scales have determined that a 3 to 5 km bandwidth maintains the integrity of data (Pocewicz & Nielsen-Pincus, 2013; Raymond & Brown, 2011; Sherrouse, Clement, & Semmens, 2011). After applying the kernel density function to both timber harvest use categories, the densities for each use category were normalized using Equation 1. To identify areas of conflict, normalized acceptable timber harvest use kernel densities were multiplied by the normalized unacceptable timber harvest use kernel densities. This non-normalized conflict raster was then normalized to create a high (1) to low (0) probability of conflict. This probability of conflict was then resampled using bilinear sampling and symbolized by deciles, with the lower two deciles removed.

Equation 1

$$P_{rel}Use_i = \frac{Use_i - MIN(Use_i)}{MAX(Use_i) - MIN(Use_i)}$$

Bivariate correlation was used to assess the relationship between acceptable timber harvest and unacceptable timber harvest use markers using the `spatstat` package (Baddeley & Turner, 2005) in the statistical software R (R Core Team, 2013). The `Lcross` function measures the distance from each acceptable timber harvest use to all unacceptable timber harvest uses at increasing radii from the acceptable timber harvest points. This function standardizes the bivariate K-function to calculate whether the two point categories are spatially distributed, random, or correlated (Beverly, Uto, Wilkes, & Bothwell, 2008). Using a Monte Carlo approach, 999 iterations (α = .001) were run to create random points within the extent of each radii around the acceptable uses. The highest and lowest bivariate K-function values for each iteration were then chosen and graphed to create a confidence envelope around the expected random spatial distribution curve

Equation 2

$$L(r) = \sqrt{\frac{K(r)}{\pi}} - r$$

Equation 2 shows Besag's standardized L(*r*) where K(*r*) is the K-function measuring the average number of points within *r* distance of each point.. All K-function values were standardized using an L-function square root transformation, with L(*r*) > 0 indicative of spatial clustering, L(*r*)= 0 a random distribution, and L(*r*) < 0 a dispersed point pattern where *r* is the radius distance (Pocewicz et al., 2012). A translation correction was used for border effects, meaning that points lying near the boundary were mirrored outside the border. Those mirrored points were then used for analyzing the points within the border. Radii distances were measured from 1 km up to 27 km.

Lastly, in order to assess the degree of spatial conflict between acceptable and unacceptable values, the Jaccard coefficient was used (Raymond & Brown, 2011). This coefficient is calculated by counting the pixels of overlap between the two timber harvest use kernel density rasters and dividing the sum of the pixels containing acceptable timber harvest densities with the pixels containing unacceptable timber harvest densities (Equation 3). This was done for both 50% conflict probability and 90% conflict probability.

Equation 3

$$J = \frac{area\ of\ conflict\ overlap}{(area\ of\ acceptable\ logging + area\ of\ unacceptable\ logging)} \times 100$$

The Jaccard coefficient was chosen to measure the degree of overlap instead of the phi coefficient (a variation of the Pearson correlation coefficient) since the latter measures overlap in comparison to the entire extent of the study area (Pocewicz & Nielsen-Pincus, 2013). Even by limiting the study area only to Wrangell Island, this still produces a somewhat misleading spatial measure, since the entirety of Wrangell Island is not available for timber production, let alone the entire Wrangell Ranger District.

3. RESULTS

Overall, the internet and paper surveys combined had an 18% response rate (n =121). Surveys were considered complete if respondents included a map with at least one value or use mapped. For the internet component, 141 respondents mapped at least one value or use, though only 70 completed a survey as well. Therefore, only 70 internet surveys were considered complete. For the paper versions, 59 surveys were submitted, though only 52 of those contained a completed map. The response rate for internet alone was 10% for eligible surveys, while only 8% for paper surveys alone. While a total of 122 surveys plus maps were considered complete, when dropping those mapped points outside of USFS lands or on water, only 121 surveys with maps were used for analysis. Of the respondents requesting paper, there was a 66% response rate, followed by a 20% response rate for the unsolicited 30 paper surveys sent out before the third postcard, and 12% for the 120 unsolicited paper surveys sent out after the third postcard. Twenty-two subjects asked to be removed from the sample while thirty-two invitation letters were undeliverable. The confidence level of this survey was 95% but because the attitudes towards the most polemic issues were split 60/30 across the sample, the sampling error calculated was 8.6% (n = 121).

3.1 Respondents compared to non-respondents

Statistical tests comparing respondents (n=121) to non-respondents (n=19) resulted in no significant differences besides an interest in forest management, with respondents being significantly more interested (χ^2 = 39.866, *df* = 3, p<.0001). Most respondents cited the complexity of the survey and absence during survey implementation as the reasons for non-response.

3.2 Socio-demographics

The distribution of respondents (n = 121) was skewed towards educated males between the ages of 60 and 69. A chi-square test for differences between respondent demographics and 2010 Census demographics indicated no significant difference in gender distribution, but a significant difference was found when further breaking down gender by age cohorts (χ^2 = 12.59, *df* = 6, p = .003) and education (χ^2 = 5.991, *df* = 2, p = .03). Where significant differences were found, weights were calculated, and applied to the necessary groups based on the population proportions. This gave more weight to underrepresented groups, such as younger females.

A chi-square test was also used to assess whether demographics influenced differing attitudes towards timber harvest. There was no significant difference between attitudes towards timber harvesting and any of the independent variables explored (gender, age, education, income from forest, percentage of food from forest, survey type, familiarity with the forest, interest in forest management, or knowledge of forest management) with one exception. Residents who had lived in Wrangell more than 10 years were significantly more likely to choose an EIS alternative with the highest timber harvest ceiling ($\chi^2 = 15.966$, df = 2, p<.0001, n = 117).

Next, when evaluating the differences between various socio-demographic variables and the frequency of values and uses mapped, either ANOVA, bivariate correlations, or independent t-tests were conducted to detect statistically significant relationships (Table 2). Respondents who used paper surveys mapped, on average, a total of 36 points (SE = 4.43), while respondents using internet maps differed significantly (F = 6.654, p<.01) by mapping an average of 23 points (SE = 2.18). There was a significant positive correlation between the average number of total markers mapped with the percentage of household food gathered from the forest (r = .334, p<.01, n = 121).There was a also a significant difference (p<.05) between the mean number of markers mapped by those without a high school education (M = 12.27, SE = 4.62, n = 9) and those respondents with some college education or higher (M = 32.94, SE = 3.33, F = 4.037, df = 2, n = 58).

Table 2. Statistically significant (p<.05) differences found between socio-demographic groups and value/use frequencies

Variable	Statistical Test	Values/Uses (p < .05)	More points place by:
Gender	Independent t-test	Recreation values	Women (p<.05)
(n = 117)		Acceptable recreation use	Women(p<.05)
Age	Bivariate	Future values	r = .180
(n = 119)	correlation	Intrinsic values	r = .241
		Acceptable commercial tourism	r = .184
		Acceptable energy use	r = .179
		Acceptable ground timber harvest	r = .214
		Acceptable non-motorized use	r = .179
		Acceptable wilderness use	r = -.238 **
		Unacceptable recreation use	r = .227

Table 2 continued

Education (n = 107)	ANOVA	Economic values	Some college or higher (Welch's F =5.489) **
		Learning values	Some college or higher (Welch's F = 3.877)
		Recreation values	Some college or higher (Welch's F = 16.646)**
		Subsistence values	Some college or higher (Welch's F = 4.272)
		Therapeutic values	Some college or higher (Welch's F = 4.875)
		Acceptable commercial tourism	Some college or higher (Welch's F = 3.691)
		Acceptable ground timber harvest	Some college or higher (Welch's F = 11.015)**
		Acceptable motorized use	High school diploma (Welch's F = 10.502)**
		Acceptable old-growth	Some college or higher (F = 3.229)
		Acceptable scenic viewshed	Some college or higher (Welch's F = 3.383)
Wrangell Residency (n = 120)	Independent t-test (cut point 10 years)	Biological values	10+ year residents**
		Economic values	10+ year residents**
		Historic values	10+ year residents**
		Unacceptable motorized use	<10 year residents
		Unacceptable wilderness use	10+ year residents

Table 2 continued

Paper vs.	Independent t-test	Aesthetic values	Paper (p<.05)
Internet		Cultural values	Paper(p<.05)
(n = 120)		Intrinsic values	Paper(p<.05)
		Acceptable commercial tourism	Paper(p<.05)
		Acceptable energy use	Paper(p<.05)
		Acceptable subsistence	Paper(p<.05)
		Acceptable wilderness use	Internet(p<.05)
Income from	Independent t-test	Acceptable ground timber harvest	Yes(p<.05)
forest		Acceptable helicopter timber harvest	Yes(p<.05)
(n = 120)		Acceptable old-growth use	Yes(p<.05)
		Acceptable road use	Yes(p<.05)

Table 2 continued

Percentage of food gathered from the forest (n = 120)	Bivariate correlation	Cultural values	r = .226
		Economic values	r = .244**
		Future values	r = .176
		Historic values	r = .189
		Life sustaining values	r = .205
		Subsistence values	r = .280**
		Acceptable commercial use	r = .185
		Acceptable ground timber harvest	r = .192
		Acceptable helicopter timber harvest	r = .179
		Acceptable motorized use	r = .202
		Acceptable non-motorized use	r = .191
		Acceptable old-growth	r = .182
		Acceptable recreation use	r = .192
		Acceptable scenic viewshed use	r = .218
		Acceptable subsistence use	r = .306**

Table 2 continued

Familiarity with forest (n = 119)	ANOVA with Tukey HSD or Games-Howell post-hoc test	Recreation values	Excellent (F = 2.633)
		Subsistence values	Excellent (Welch's F = 9.985)**
		Therapeutic values	Poor (Welch's F = 4.713)
		Acceptable motorized	Excellent (F = 2.963)
		Acceptable recreation use	Good (Welch's F = 5.874)**
		Acceptable road use	Good (Welch's F = 5.805)**
		Acceptable subsistence use	Good (Welch's F = 3.243)
		Acceptable wilderness use	Excellent (F = 3.466)
Interest in forest management (n = 120)	ANOVA with Tukey HSD or Games – Howell post-hoc test	Biological values	Very (Welch's F = 4.242)
		Cultural values	Very (Welch's F = 8.568)**
		Economic values	Very (Welch's F = 4.599)
		Future values	Very (Welch's F = 8.155)**
		Therapeutic values	Very (F = 3.412)
		Spiritual values	Somewhat (Welch's F = 2.052)**
		Acceptable energy use	Very (Welch's F = 9.936)**
		Acceptable ground timber harvest	Very (Welch's F = 7.742)**
		Acceptable recreation use	Very (F = 6.177)
		Unacceptable ground timber harvest	Very (Welch's F = 11.985)**
		Unacceptable road use	Very (Welch's F = 6.054)

Table 2 continued

Knowledge of forest management (n = 120)	ANOVA with Tukey HSD or Games-Howell post-hoc test	Acceptable energy use	Excellent (Welch's F = 3.040)
		Acceptable ground timber harvest	Excellent (F = 7.994)
		Acceptable helicopter timber harvest	Excellent (F = 6.839)
		Acceptable motorized use	Excellent (Welch's F = 9.320)**
		Acceptable recreation use	Good (F = 2.514)
		Acceptable road use	Excellent (Welch's F = 6.203)**
		Unacceptable commercial tourism	Excellent (Welch's F = 2.626)

** sig at p<.01

3.3 Use Preferences

For forest use preferences (Appendix A, Section 2 of the survey), respondents were given a list of 16 forest uses and asked to scale how strongly they favored or opposed the use on a Likert scale from 1 (strongly oppose) to 5 (strongly favor). Respondents' scores were plotted against the frequency of each value category the respondent mapped to examine if a correlation existed between use preference scores and frequency of values mapped (Table 3). Weak but significant correlations existed between many use preferences and values with two value and use preferences resulting in a higher significant correlation than others: respondents who strongly favored sight-seeing placed significantly more aesthetic values, while those who strongly favored wilderness mapped fewer economic values. Timber harvest activities were negatively correlated with life sustaining and recreation values.

Similar analysis was done between cognitive forest use preferences and spatial forest use frequencies (Table 4 and Table 5). Many of the cognitive forest use preferences correlated with the equivalent spatial forest use. For example, higher motorized land recreation preference scores were correlated with higher frequencies of mapped acceptable motorized use. As expected, timber harvest preference scores had the highest correlation with acceptable ground timber harvest uses. The score that had the highest negative correlation with acceptable ground timber harvest was wilderness use preference.

Table 3. Forest use preference scores significantly correlated with landscape values (p<.05)

Forest Use Preference [a]	Mean Score	Positive Correlation (r)	Sample size (n)	Negative Correlation (r)	Sample size (n)
Sight seeing	4.63	Aesthetic (.277)**	65		
		Recreation (.202)	77		
		Spiritual (.182)	28		
Sport fishing	4.72				
Non-motorized land based recreation	4.42	Intrinsic (.372)	24		
		Therapeutic (.336)	37		
Sport hunting	4.53			Learning (-.186)	22
Non-motorized water based recreation	4.28	Recreation (.185)	77		
Helicopter skiing or hiking	3.36				
Wildlife viewing or observing	4.61	Intrinsic (.218)	24		
Motorized land based recreation	3.94			Cultural (-.208)	28
Commercial mining	3.19			Therapeutic(-.197)	35
Motorized water based recreation	4.61				

Table 3 continued

Gathering forest products	4.76	Aesthetic (.217)	65		
		Economic (.188)	37		
		Recreation (.184)	78		
Commercial outfitting or guiding	3.76				
Communication site or utility easement	3.99				
Wilderness	3.88	Aesthetic (.224)	60	Economic (-.264)**	36
Subsistence hunting or fishing	4.70	Future (.298)	29	Economic (-.390)	36
		Recreation (.192)	76		
Timber harvest activities	3.92			Life sustaining (-.191)	17
				Recreation (-.183)	48

** sig at p<.01

[a] In response to the question: "How do you feel about these public uses on the Tongass, specifically on the Wrangell Ranger District?" 1 - Strongly Oppose, 2 – Oppose, 3 – Neither, 4 – Favor, 5 – Strongly Favor

Table 4. Forest use preference scores significantly positively correlated with acceptable/unacceptable spatial uses (n =121, p <.05)

Forest Use Preference	Mean Score	Positive Correlation	Correlation Coefficient (r)	Sample size (n)
Sight seeing	4.63	Acceptable road use	.195	46
Sport fishing	4.72	Acceptable energy use	.231	33
		Acceptable helicopter timber harvest	.236**	46
		Acceptable motorized use	.256**	54
		Acceptable recreation use	.235**	57
		Acceptable road use	.188	45
Non-motorized land based recreation	4.42	Unacceptable ground timber harvest	.246**	30
		Unacceptable helicopter timber harvest	.254**	22
Sport hunting	4.53	Acceptable energy use	.231	33
		Acceptable helicopter timber harvest	.188	47
		Acceptable motorized use	.357**	54
		Acceptable recreation use	.210	58
		Acceptable road use	.284**	46
Non-motorized water based recreation	4.28	Unacceptable ground timber harvest	.200	30
		Unacceptable helicopter timber harvest	.223	22

Table 4 continued

Wildlife viewing or observing	4.61	Acceptable wilderness	.206	13
Motorized land based recreation	3.94	Acceptable energy use	.198	33
		Acceptable ground timber harvest	.220	47
		Acceptable motorized use	.388**	53
		Acceptable recreation use	.249**	58
		Acceptable road use	.237**	46
Commercial mining	3.19	Acceptable energy use	.250**	33
		Acceptable ground timber harvest	.271**	47
		Acceptable helicopter timber harvest	.191	32
		Acceptable motorized use	.484**	53
		Acceptable recreation use	.222	58
		Acceptable road use	.335**	46
		Unacceptable old-growth use	.236	5
Motorized water based recreation	4.61	Acceptable commercial tourism	.214	26
		Acceptable ground timber harvest	.244**	47
		Acceptable helicopter timber harvest	.289**	33
		Acceptable motorized use	.307**	54
		Acceptable road use	.237**	46

Table 4 continued

Gathering forest products	4.76	Unacceptable helicopter timber harvest	.222	22
Commercial outfitting or guiding	3.76	Acceptable motorized use	.204	54
		Acceptable recreation use	.199	58
Communication site or utility easement	3.99	Acceptable energy use	.260**	33
		Acceptable ground timber harvest	.256**	47
		Acceptable helicopter timber harvest	.179	33
		Acceptable motorized use	.210	54
		Acceptable recreation use	.287**	58
		Acceptable road use	.220	46
		Unacceptable wilderness use	.210	10
Wilderness	3.88	Unacceptable ground timber harvest	.219	27
Timber harvest activities	3.92	Acceptable energy use	.199	33
		Acceptable ground timber harvest	.467**	47
		Acceptable helicopter timber harvest	.274**	33
		Acceptable motorized use	.266**	54
		Acceptable road use	.329**	46

** sig at p<.01

Table 5. Forest use preference scores significantly negatively correlated with acceptable/unacceptable spatial uses (n =121, p <.05)

Forest Use Preference	Mean Score	Negative Correlation	Correlation coefficient (r)	Sample size (n)
Non-motorized land based recreation	4.42	Acceptable energy use	-.261**	31
Non-motorized water based recreation	4.28	Acceptable energy use	-.199	33
		Acceptable road use	-.188	45
Motorized land based recreation	3.94	Unacceptable ground timber harvest	-.258**	30
		Unacceptable road use	-.254**	29
Commercial mining	3.19	Unacceptable ground timber harvest	-.192	30
Commercial outfitting or guiding	3.76	Unacceptable commercial tourism	-.182	10
Communication site or utility easement	3.99	Unacceptable road use	-.249**	29
Wilderness	3.88	Acceptable energy use	-.229	25
		Acceptable ground timber harvest	-.303**	40
		Acceptable road use	-.362**	38
		Unacceptable wilderness use	-.252	9

Table 5 continued

Timber harvest activities	3.92	Unacceptable ground timber harvest	-.377**	29
		Unacceptable helicopter timber harvest	-.249**	21
		Unacceptable road use	-.367**	29

** sig at p<.01

3.4 Attitudes

Since many questions on the survey addressed attitudes towards forest management, the question most pertinent to Wrangell Island EIS alternatives was chosen for analysis. This question assessed respondents' attitudes towards harvesting timber on Wrangell Island over the course of 10, 20, or 30 years (Appendix A, Question 18 on the survey). The majority of respondents chose the largest timber volume over the shortest time period (Figure 11).

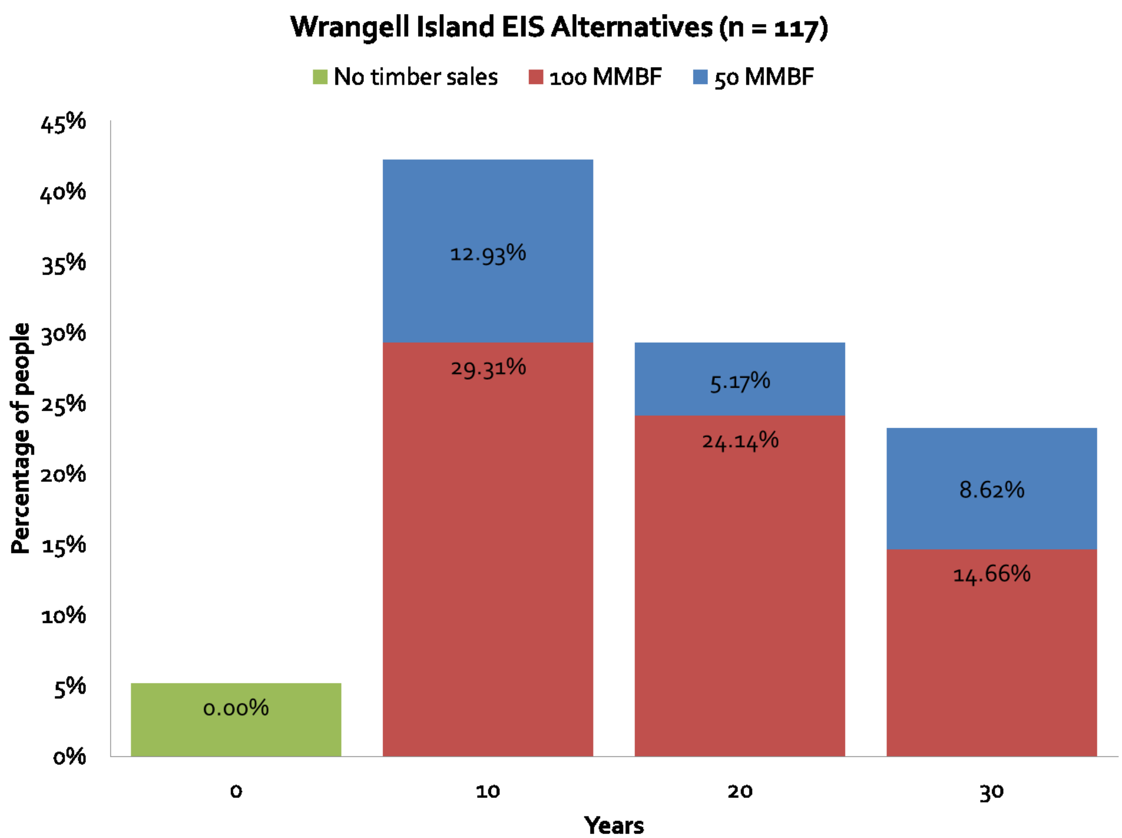

Figure 11. Percentage of respondents favoring Wrangell Island EIS alternatives

Discriminant function analysis was run using the frequencies of the 13 landscape values as predictor variables to classify respondents based on their attitude towards timber harvest. Using the six categories for timber harvest alternatives (after dropping the no timber sale alternative, n = 110), 5 discriminant functions were revealed. The first discriminant function explained 44.3% of the variance, with a R^2 =.324, meaning a moderate effect size. Combined, the five functions significantly differentiated between the cases (Wilks' lambda =

.387, χ^2 = 95.635, *df* = 65, p = .008). Yet removal of any further functions meant that the attitude groups could no longer be differentiated significantly. Recreation (r = .627), biological (r = .578), and spiritual (r = .510) values were the best predictors of grouping cases for the first function. Overall, only 32.9% of the cross validated cases were grouped correctly but based on chance alone, one would be able to correctly classify an individual only 16.7% of the time. This indicates that while discriminant function analysis has poor predictability for classifying an individual based on knowledge of their values alone, it is still a better predictor than chance alone. Further, Box's M indicated a statistically significant test (F = 3.45, p<.000) meaning that the null hypothesis of equal covariance matrices was violated. Given the small sample size, this indicates that the significance of values predicting attitudes (p = .008) is a liberal estimate.

3.5 Landscape Values and Spatial Forest Uses

As stated before, 122 respondents mapped points and completed surveys. Yet, when dropping points outside of the WRD and dropping points more than 2.25 kilometers away from USFS land (e.g., off-shore or on private/state land), the number of surveys that had at least one point mapped were reduced to 121. This tolerance for points falling within a 2.25 km buffer of USFS land allowed for irregularities in map boundaries and imprecision of mapping by respondents. Since respondents using the internet maps could map an indefinite amount of points, only the first 5 points for each category were considered for analysis, under the assumption that points were mapped in order of priority. This standardized the number of points mapped by internet respondents with the paper surveys, since the paper surveys were limited to only 5 points each for the 39 different categories. As well, because internet points could be mapped at a finer spatial scale, duplicated category points falling within 2.25 km of each other were removed. The intention of this was to keep the mapped internet points at the same scale as paper mapped points, which had a diameter of roughly 2.25 km on the ground. To analyze the values in respect to timber harvest uses, acceptable helicopter and acceptable ground timber harvest uses were combined to create the acceptable timber harvest use feature class. Similarly, unacceptable helicopter and unacceptable ground timber harvest uses were combined to create the unacceptable timber harvest use feature class for spatial analysis.

The median frequency of values and uses was 22 per respondent (SE = 2.23). Appendix C, Table C-1 summarizes the descriptive statistics for each value and use. Most values/uses had a bimodal distribution, with respondents who mapped at least one value mapping either just one or all five of the points per that value/use category. Of the 121 respondents, 97 of them mapped their maximum allocated points (5) for at least one value or use category. Two respondents mapped their maximum allotted points for 35 of the 39 different value and use categories.

Recreation, aesthetic, subsistence, and biological values were not only the values mapped by the highest percentage of respondents (Figure 12), but were also the most frequently mapped values (Figure 13). The acceptable uses most often mapped were subsistence use, recreation use, motorized use, and ground timber harvest. These were also the acceptable uses mapped by the highest percentage of respondents. The highest percentage of respondents mapping unacceptable uses chose ground timber harvest, road use, helicopter timber harvest, and wilderness use; similarly, the most frequently mapped unacceptable uses were ground timber harvest, helicopter timber harvest, road use, and wilderness use.

To explore the cognitive relationship between landscape values and spatial forest uses, Spearman's product moment correlation was used (Table 6). Many of the 13 landscape value categories were positively correlated with unacceptable ground timber harvest, with aesthetic, cultural and subsistence landscape values being statistically significant at $p <.01$. Most of the same landscape values associated with unacceptable ground timber harvest were positively associated with acceptable old-growth use. Of note, the highest correlation between any value and use was the relationship between acceptable old-growth use and economic value ($r = .907$, $p < .01$).

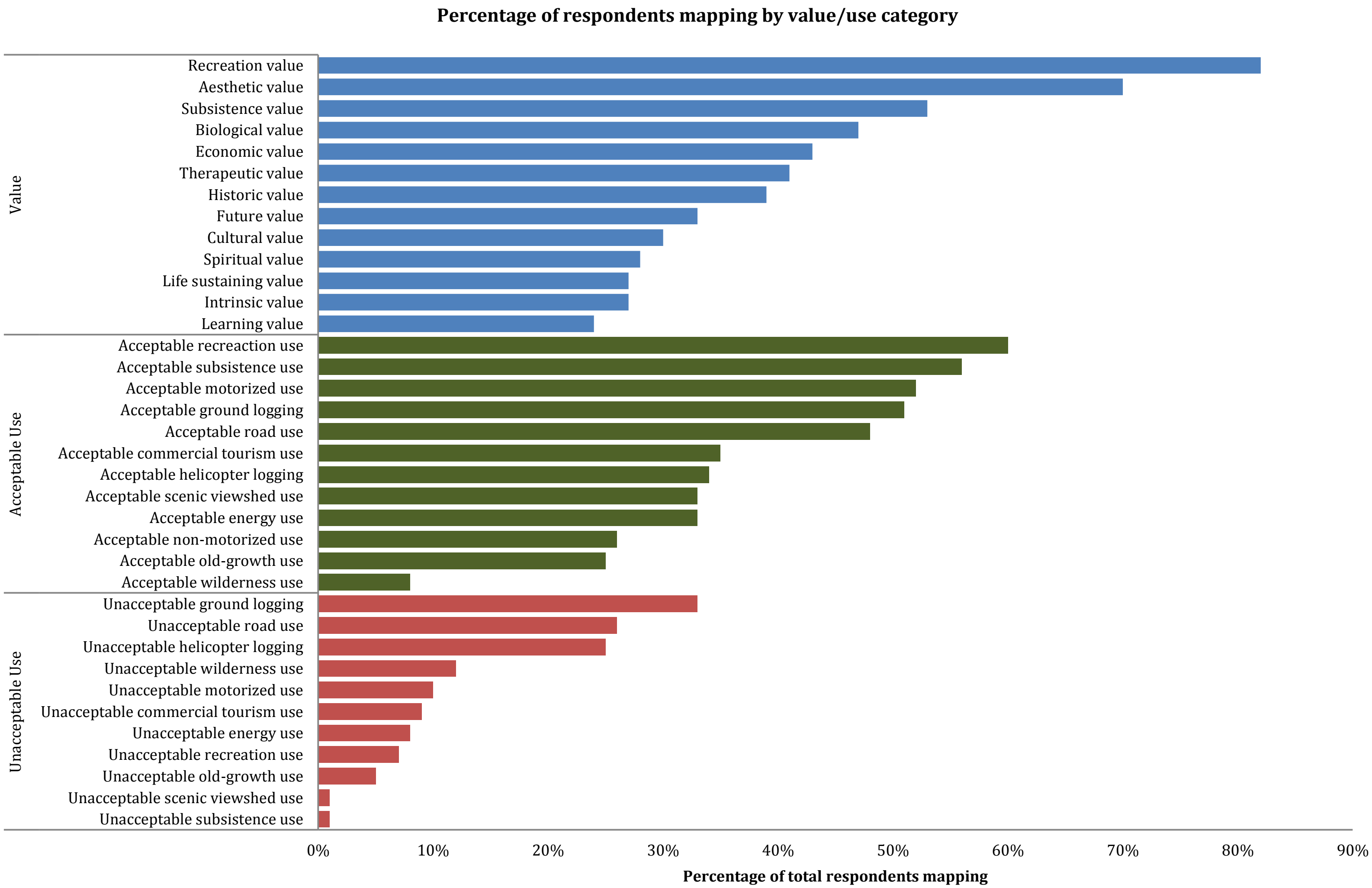

Figure 12. Percentage of respondents mapping by value/use category

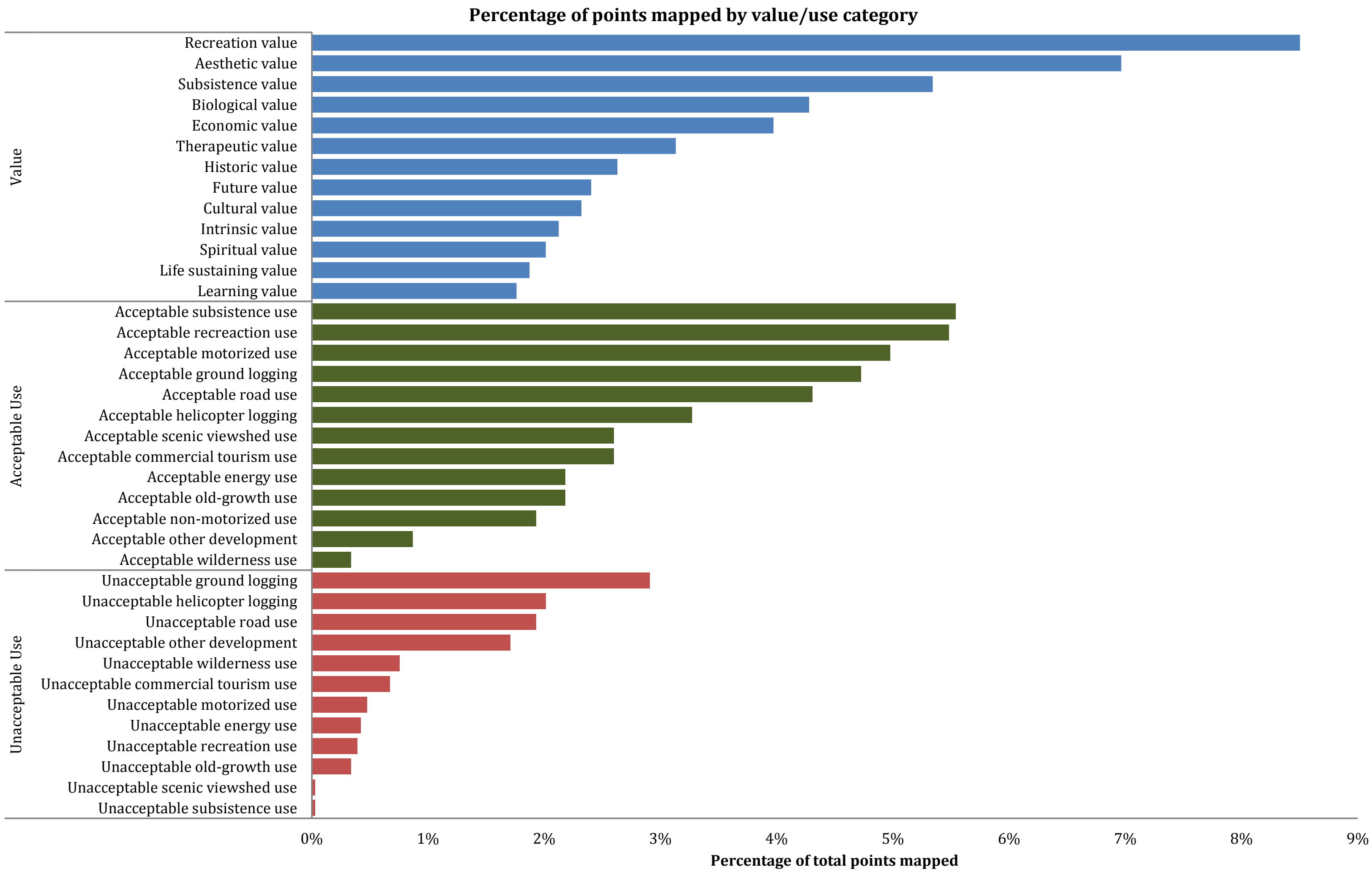

Figure 13. Percentage of points mapped by value/use category

Table 6. Cognitive bivariate correlation of spatial forest values to spatial forest uses (p<.05)

Spatial Forest Uses	Acceptable Forest Uses	Unacceptable Forest Uses	Sample size (n)
Commercial tourism	Cultural (.572)		9
	Intrinsic (.642)**		10
Energy	Cultural (.669)		10
	Intrinsic (.568)		13
	Life Sustaining (.594)		11
Ground timber harvest		Aesthetic (.557)**	21
		Biological (.536)	16
		Cultural (.781)**	14
		Intrinsic (.770)	6
		Spiritual (.617)	13
		Subsistence (.613)**	19
		Therapeutic (.546)	14
Helicopter timber harvest		Aesthetic (.642)**	16
		Cultural (.693)	10
		Subsistence (.517)	15
Motorized	Cultural (.642)		8
	Subsistence (.451)		16
Non-motorized	Biological (.606)		10
	Economic (.730)**		11
	Future (.750)		8
	Intrinsic (.905)		6
	Therapeutic (.742)**		12

Table 6 continued

Spatial Forest Uses	Acceptable Forest Uses	Unacceptable Forest Uses	Sample size (n)
	Aesthetic (.529)		17
	Cultural (.815)**		10
Old-growth	Economic (.907)**		10
	Future (.771)**		8
	Historic(.611)		11
	Life sustaining (.667)		11
	Spiritual (.810)**		10
	Subsistence (.582)		13
	Therapeutic (.788)**		10
	Biological(.460)		24
Recreation	Cultural(.578)		15
	Life sustaining (.538)		18
	Recreation (.397)**		39
		Aesthetic (.506)	24
Road		Future(.661)	10
		Intrinsic (.686)	8
		Recreation(.607)**	25
		Spiritual(.667)	12
	Economic (.556)		17
Scenic viewshed	Intrinsic(.632)**		15
	Learning (.616)		10
	Life sustaining (.785)**		17
	Recreation (.388)		27
	Therapeutic (.703)**		18

Table 6 continued

Spatial Forest Uses	Acceptable Forest Uses	Unacceptable Forest Uses	Sample size (n)
Subsistence	Cultural (.732)**		16
	Learning (.672)**		11
	Life sustaining (.746)**		18
	Therapeutic (.746)**		16
Wilderness		Recreation (.827)	4

** sig. at p <.0

Landscape values were first assessed for clustering at increasing distances from each point. This test for clustering (multi-distance spatial clustering) was significant for each of the thirteen values at all distances from 2km up to 20 km. Spatial relationships were then compared between the thirteen values and the spatial timber harvest uses, based on value counts within varying measures of proximity (Figure 14). Within 1 km of each acceptable timber harvest use point, the highest proportion of values mapped were recreation (22%), followed by subsistence (16%), aesthetic (11%), and economic (10%). For the proportion of values within 1 km of unacceptable timber harvest use points, recreation (19%), aesthetic (17%), and subsistence (14%) were followed by economic (7%).

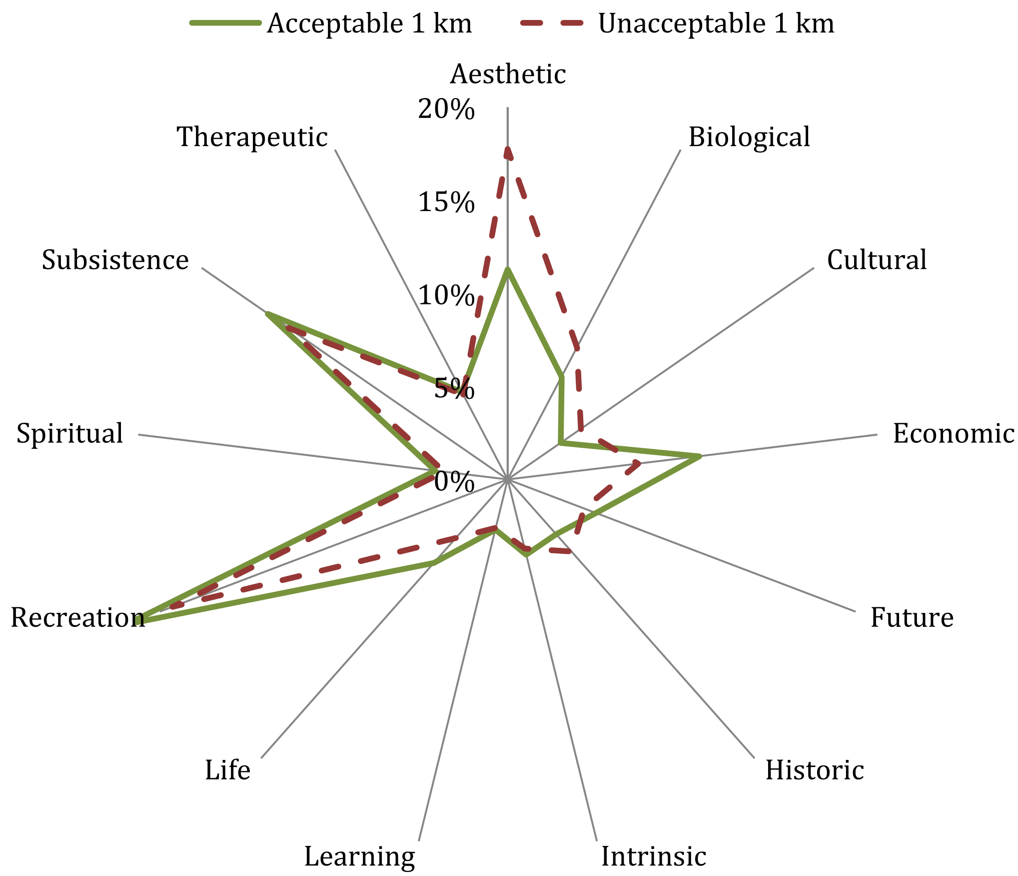

Figure 14. Radar plot of values within 1 km radius of acceptable and unacceptable helicopter and ground timber harvest points. Percentages represent proportion of points per category from the total points within the 1 km radius.

3.6 Spatial Forest Use Conflicts

The first and third largest percentage of unacceptable points mapped were ground timber harvest and helicopter timber harvest (Appendix C, Table C-1). Both acceptable and unacceptable timber harvest uses were assessed for spatial clustering at varying distances using the standardized values of Ripley's K, and both types of timber harvest uses were found to cluster at all distances between 2 km and 20 km. Normalized kernel density maps showing acceptable timber harvest use, unacceptable timber harvest use, and conflicting timber harvest use, as well as areas of acceptable timber harvest use that do not overlap with unacceptable timber harvest use are in Appendix B. A histogram of conflict distribution in square kilometers across only Wrangell Island is shown in Figure 15.

Areas of acceptable and unacceptable timber harvest uses were spatially clustered together, as evidenced by the bivariate K-function graph Figure 16. This clustering was also seen in the Figure B-3 in Appendix B.

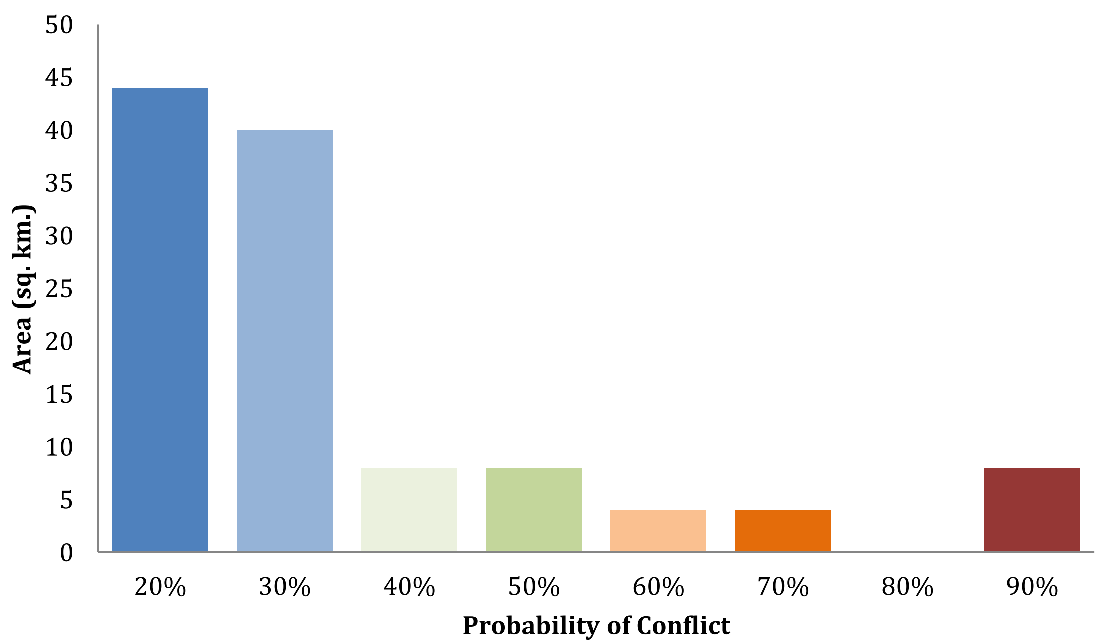

Figure 15. Histogram of the probability of conflict by square kilometers

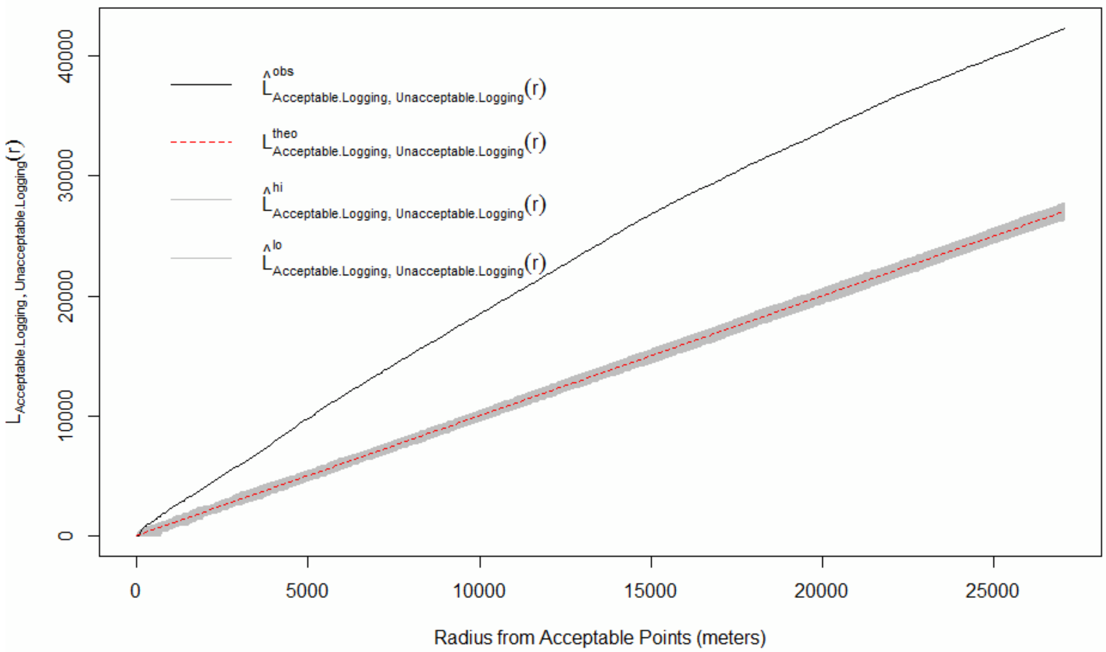

Figure 16. Standardized bivariate spatial correlation, L(*r*), between acceptable and unacceptable timber harvest uses. The observed L(*r*) is greater than the expected L(*r*), indicating significant spatial clustering at all scales.

The Jaccard coefficient for the area with a 50% probability of conflict indicates a low degree of overlap, with 2.3% of acceptable and unacceptable timber harvest uses overlapping. The areas with a 90% probability of conflict indicated an even smaller degree of overlap, with less than 1 % of acceptable and unacceptable uses overlapping (8 sq. km). With the area of Wrangell Island at roughly 572 sq. km., those areas with a probability of 90 to 100% conflict made up 8 sq. km, while the areas with 50% probability of conflict made up 24 sq. km.

4. DISCUSSION

Although the response rate for this study was less than 20%, the mixed method approach resulted in a higher response rate than using internet methods alone. As well, while many internet maps were completed, far fewer internet surveys were completed. Because respondents conducted the mapping portion prior to completing the internet surveys, the difference between maps and surveys completed could be explained by the fact that respondents closed the internet browser window after completing their mapping exercises without moving on to the survey portion. Even with this flaw in the internet survey design, more respondents completed the internet survey than the paper survey. This is in spite of the effort to increase survey response rates by distributing the full paper survey/mapping package to 30, then 120 random respondents, all of which only increased response rates by 3%. Another reason for low response rates may have been the error in the login code that was distributed with the third postcard. When the non-respondents contacted by phone, they cited the complexity of the survey as the main reason for non-response, another compounding factor in low response rates. One reason voiced by multiple respondents as to why paper respondents mapped on average more points than internet respondents may have been that the limitation of points to map (5 per value/use category) gave paper respondents clear expectations, while the infinite number of points available to internet users appeared a daunting task.

4.1.1 Socio-demographics

Other studies have found similar skews in education, age, and gender distributions, with older, educated males dominating the distribution of respondents (Brown & Reed, 2009; Clement & Cheng, 2011). Although Clement and Cheng (2011) suggest stratifying samples based on gender, given the small sample size with the limited resources available for this case study, such sampling plan methods were cost prohibitive. Similar to other studies, younger residents were more likely to submit surveys via the internet. In contrast to other mixed method studies, there was no difference between women and men using internet, nor were those with a higher education more likely to submit internet surveys (McFarlane & Boxall, 2000; Pocewicz et al., 2012).

Residents who have lived in Wrangell more than 10 years were the only group to have statistically significant differences in attitudes towards timber harvesting when compared to residents who were newer to the community. In the cognitive hierarchy theory, vocational occupation is often related to value orientation (McFarlane & Boxall, 2000). Since the mill was the largest employer in Wrangell until 2006 (Juneau Economic Development Council, 2011b), there is a high probability that respondents living in Wrangell more than 10 years were directly affected by the closure of the mill. Therefore, attitudes supporting timber harvest from this sample sub-group may be a reflection of previous employment or relations to those previously employed. These ties to collective memories may also be reflected by the resulting tests indicating that those residents living less than 10 years in Wrangell mapped a significantly higher number of unacceptable motorized uses, a possible indication of differing perceptions of the Roadless Rule of 2001. Previous to 2001, areas now inventoried as roadless contained roads available to the public for use. This rule altered the forest use activities of longer-term residents, whom may still perceive these areas as acceptable for motorized uses.

While it was important to identify any differences between groups mapping values and uses so as to detect biases in the sample, the socio-demographics of stakeholders have no bearing on stakeholder standing during the NEPA process. Although this knowledge could be used to predict attitudes or values, the demographics such as the sex or age of commenters are extraneous to the task of managers who process the public scoping comments for inclusion in NEPA documents.

4.1.2 Use Preferences

A previous study done by Brown (2013) has shown a positive correlation between higher timber harvest preference scores and economic values, as well as a high negative correlation with life-sustaining and learning values. The findings of the Wrangell case study had similar negative correlations between life-sustaining values and timber use preferences. In the Wrangell case study, recreation values were negatively correlated with timber harvest use preference scores, but were then found to be the highest proportion of values mapped near acceptable timber harvest uses. This may be an artifact of how the proportion of landscape values nearest acceptable timber harvest uses was calculated. The proportion was calculated from the proportion of points for each category of values compared to the total number of points mapped within each radius distance. Since recreation was mapped the most frequently, had the highest probability of clustering, and the lowest mean distance to nearest neighbor (1.248 km), it was more likely that the proportion of recreation values near timber harvest uses would be higher for both acceptable and unacceptable timber harvest. This does not necessarily expose the relationships between recreation values and timber harvest uses per individual respondent. The proportional nearest neighbor method analyzed the cumulative spatial relationship instead of assessing spatial relationships of values and uses mapped per individual. For example, one individual may map recreation values in the same place as another individual maps acceptable timber harvest uses, but the amalgamated spatial relationships display those recreation points near acceptable use irrespective of individuals.

By correlating the forest use preferences with spatial forest uses, construct validity of the survey was verified, indicating that cognitive forest use preferences were associated with the corresponding spatial use. For example, both motorized land-based and water-based recreation forest use preferences were highly positively correlated with acceptable motorized use frequencies. As framed by the cognitive hierarchy, the verification of this construct can further bolster the theory of values predicting attitudes.

4.1.3 Attitudes

Working within the theory of cognitive hierarchy, the discriminant function analysis conducted here further supports the theory that values do influence attitudes. Although value frequency was not a strong predictor of attitudes in this research, the fact that recreation value was the greatest predictor in discriminant function analysis was similar to Clement-Potter (2006). Yet, given the low probability of discrimination compared to classification based on random chance alone, especially in light of the low Box's M, using values alone to predict harvest attitude categories is dubious at best. While an initial chi-square test did return significant differences between the distributions of harvest attitudes, the low power of discriminating factors may reflect a lack of polarity in Wrangell residents when it comes to values predicting attitudes on timber harvesting.

Regardless of the underlying values associated with timber harvest attitudes, with over 95% of respondents in favor of some type of timber harvest, the question regarding timber harvest on the Wrangell Ranger District then would be just how much and where to harvest. While 30% of respondents favored an EIS alternative which cut 100 MMBF over the course of 10 years, recent timber cruise estimates for harvest units potentially included in the Wrangell Island EIS now set the proposed volume at 60 MMBF (Federal Register, 1 August 2013). A confounding factor within the harvest attitudes question was the complex, double-barreled question format that, while intending to give respondents a clearer definition of the choices provided, may have confused the issue. For example, respondents were given the option to harvest over the course of "10 years: 50 MMBF cut at 5 MMBF per year (roughly 40 local jobs per year for 10 years)[4]". It would thereby be difficult to ascertain whether respondents were indicating attitudes towards economics priorities, attitudes towards sustained yield, attitudes toward volume harvest limits, or attitudes towards harvest schedules. Thus, any recommendations arising from this case study should not simply produce a timber harvest volume ceiling but should instead suggest sustainable yield parameters to work within.

4.1.4 Landscape Values and Spatial Forest Uses

In a previous study on forest use mapping, a highly significant correlation was found between the frequencies of spatial acceptable timber uses and economic and recreation values , as well as between the frequency of unacceptable timber harvest uses and learning, biological, and life sustaining values (Brown, 2013). Yet, the Wrangell case study did not reveal any significant correlations between acceptable timber harvest uses and landscape values (Table 6). Those values that did correlate with unacceptable timber harvest uses were not similar to those correlating in Brown's study, except biological values. The very

[4] 2.3 logging jobs and 3.4 sawmilling jobs are created annually for every MMBF of sawtimber harvested on the Tongass (Alexander et al., 2010).

high correlation between economic values and acceptable old-growth use in the Wrangell case study suggests a cognitive correlation that is not necessarily spatial. Post-hoc spatial analysis indicated that on an aggregated spatial scale, the bivariate standardized K-function between economic and old growth points fell into the confidence envelope for random distribution at certain distances (Appendix D). This indicates that the relationship between economic value and old-growth use is more likely cognitive as opposed to spatial and could be based on the awareness of respondents that old-growth forests provide many economically valuable timber and non-timber products.

Interestingly, wilderness was the fourth highest mapped unacceptable forest use with 12 different individuals mapping a total of 27 different points. The reason for such a high frequency may be twofold. Firstly, rural residents often place fewer wilderness values than urban residents (Pocewicz & Nielsen-Pincus, 2013). Secondly, the high rate of unacceptable wilderness use may be a reflection of Alaskan politics. Half of the unacceptable points mapped fell in current wilderness areas, which make up over 500,000 acres of the WRD. The Stikine-Le Conte Wilderness and South Etolin Wilderness are encompassed by the Wrangell Ranger District and were established under ANILCA in 1980 and TTRA in 1990, respectively. Traditionally, wilderness areas designated under these acts have been points of contention between Alaskans and federal agencies, especially in areas with customary and traditional use, such as the Stikine River on the WRD (Nie, 2006). The negative correlation between age and acceptable wilderness uses mapped ($r = -.238$, $p < .01$) may also be explained by these changes in land use designation. Older residents of Wrangell witnessed the application of sudden and intense restrictions, which altered – and in some cases, halted - their previous activities in these newly created wilderness areas, especially on the Stikine River. Along with this hypothesis, those respondents with greater than 10 years of Wrangell residency mapped a significantly higher proportion of unacceptable wilderness uses. Similarly, the frequency of respondents placing unacceptable spatial wilderness uses was positively correlated ($r = .827$, $p < .05$) with the frequency of respondents mapping recreation values. This indicates that those who value recreation highly found more areas as unacceptable for wilderness designation than those who did not value recreation as highly. This may seem contradictory, given the high rate of recreation in wilderness areas, assuming that recreation values reflect non-motorized recreation. Yet, much of the recreation occurring on the Stikine River includes motorized transportation operating under certain ANILCA restrictions. Thus, wilderness uses and recreation values may be viewed as incompatible by respondents who prefer motorized recreation, although the spatial relationship between unacceptable wilderness and recreation per individual respondent was not explored.

Caution should be exercised when assessing the types of values closest to areas of acceptable and unacceptable timber harvest use. As discussed with frequency correlations between economic values and acceptable old-growth uses, as well as frequency correlations between wilderness use and recreation values, the aggregated values and uses do not indicate spatial autocorrelation on a per individual respondent basis. Care should be taken when interpreting the spatial relationships of values nearest acceptable and unacceptable timber harvest uses. The purpose of identifying values nearest acceptable and unacceptable uses would be to assess what types of forest management options are available to USFS managers.

Depending on the distance between values and acceptable harvest markers, management options may include avoidance or less intense management strategies. For example, aesthetic values mapped closely to acceptable timber harvest uses may in fact be viable spots for cable yarding log decks during even-aged harvest, opening up scenic view sheds for future use as recreation sites similar to the Yunshookuh Campground in the Nemo Timber Sale area on Wrangell Island. Landscape values such as subsistence or learning near areas deemed as acceptable timber harvest by large portions of the public may be candidate stands for regeneration methods such as uneven-aged selection combined with an aerial harvest system like helicopter timber harvest. Areas within timber harvest land use designations that are highly valued for biodiversity may better serve the public as old-growth reserves, a change that is possible with a forest plan amendment. Areas with life sustaining value may require more intense management with resource specialists providing detailed input for silvicultural prescriptions that minimize erosion or hydrologic changes. A more quantifiable option for assessing the incompatibility of values with uses includes

Values Compatibility Analysis. Managers determine a priori incompatible values and uses, such as even-aged harvests with cultural values, and then weight the intensity of incompatibility. Maps are then created with the applicable uses and values to pinpoint hotspots of incompatible values and uses (Brown & Reed, 2011).

4.1.5 Spatial Forest Conflicts

Unlike the spatial relationships between values and timber harvest uses, the spatial relationships between acceptable and unacceptable timber harvest uses are incompatible, irrespective of individual responses. This is because one use cannot coexist spatially with the other. When taking into account conflict, those areas that had a low degree of overlap still had a very high degree of potential conflict, indicating that managers' time would be best served avoiding these areas and focusing their efforts on the areas of lower probability of conflict (40 to 20%) with less overlapping conflict, assuming these areas provide viable timber volume.

Spatially, those areas deemed as acceptable for timber harvest that do not overlap with unacceptable timber harvest should be explored by managers for further viability as inclusion in timber harvests, accounting for land use designations, transportation system, and harvest system compatibility. For example, Appendix B, Figure B-4 displays these acceptable areas (with conflicting timber harvest areas omitted) within land use designations for timber harvesting. Other regulations and legislation such as the Roadless Rule, TTRA stream buffers, and harvest unit acreage restrictions also limit areas available for timber harvest. Finally, the availability of timber volume and feasibility of timber harvest systems further adds to the challenge of spatially designating areas suitable for timber harvest.

4.2 Limitations

While landscape values can provide managers with a deeper understanding of public preference and attitudes, landscape values work within the parameters of several limitations. First, assigning values to a specific point is difficult for many respondents. Comments with the mapped values often included statements indicating that respondents felt certain values were not mappable. Other respondents wanted to apply the point marker to a large area, in effect drawing polygons. Other landscape values studies have explored the potential of using polygons instead of points to delineate an area for value (Brown & Pullar, 2011; Cacciapaglia, Yung, & Patterson, 2012). These studies found that while polygons can incorporate more inherent, intangible values (e.g., intrinsic values), the courser spatial scale increased ambiguity for more material values (e.g., economic, recreation) or for more sensitive uses (e.g., undisclosed subsistence areas). Further research could identify those values best mapped using points and the values best mapped as polygons.

On a similar note, the scale of the paper survey limited interpretation of the results. The diameter of the stickers used on the paper maps represented almost 2 km on the ground, meaning that some of the smaller islands were completely obscured by the stickers that respondents placed on the islands. This prevented any fine scale analysis to determine the types of values associated with the underlying timber volume. Internet survey respondents had the option to zoom in to a much finer scale. As well, the scale at which internet points were mapped was recorded with the attributes of that point, meaning that researchers could theoretically assess if certain values were mapped at a higher or lower scale. This information could assist in choosing the bandwidth for use in kernel density estimates or as weight inputs for inferential statistics such as Getis-Ord General G statistic.

Previous studies have used ranking or weighting within the landscape values mapping exercise to assess the importance of values to individuals (Brown & Reed, 2009), and while frequency now serves as an appropriate proxy for the cognitive intensity of values, this does not solve the problem of assessing the intensity of a value assigned to an area. Without explicitly informing respondents that the area in which they map values will count towards the intensity of their values, post-hoc weights cannot be applied to landscape value points.

Mapping landscape values provides managers with the answer to many of the “where?” questions, but often glosses over the “why?” questions. Although respondents were encouraged to write in comments on areas they mapped, very few of the points had explanations for the values assigned to the area. Although this could be viewed as a limitation in landscape valuation methods, this lack of depth also provides a starting point for open dialogue between managers and the public during scoping meetings.

Lastly, landscape values only help managers make decisions. Landscape values are not a decision making tool. Landscape values are not meant to replace the NEPA scoping process but are intended to augment the process by adding a spatial component. Although decisions made in the planning realm are political in nature and require public input from voting adults, landscape values are not a vote. The deciding official (the district ranger and the forest supervisor in the case of the Wrangell island EIS) have the ultimate decision in recommending and approving an alternative, though ideally these decisions sincerely consider public input. As well, public lands in a sense belong to all the citizens of the U.S., so while local values are an important part of the management puzzle, these should not hold more weight than those who live across the nation. Spatial autocorrelation posits that respondents will value more areas nearest to their locations. This is key for identifying site specific plans, but should not negate the opinions of other members of the public across the nation. One example to expound on the difficulties with weighting local values would be wilderness use. Wilderness perceptions of Alaskans are believed to be different than U.S. residents from the contiguous 48 states (Brown, Watson, & Alessa, 2001). Weighting wilderness values based on local Alaskan attitudes, as shown in the case of Wrangell citizens mapping more unacceptable wilderness uses in designated wilderness areas, may result in different management decisions than what the rest of the nation prefers on their public lands.

4.3 Recommendations

Based on the attitudes reported in this survey, all but 4.5% percent of the random sample wishes to see some form of timber harvest occur, with the majority favoring the largest timber volume harvest feasible. This indicates that for the most part, residents favor some form of timber harvest, with the remaining questions being how much and where? On average, respondents wished to see 4 to 5.5 MMBF cut over the course of 17 to 20 years, resulting in a total of 80 to 93 MMBF timber volume harvested. While only a small percentage of area on Wrangell Island holds any known potential of conflict between acceptable and unacceptable timber harvest uses, these areas occur in the potential timber sale areas for the Wrangell Island EIS. This area comprises 8 sq. km. (roughly 1,900 acres) and is recommended for exclusion from the Wrangell Island EIS.

With the wide variety of attitudes towards timber harvest ceiling as well as the exclusion of large portions of the Wrangell Island EIS, other variables in the survey were explored post-hoc to assess the final goals of the community. With 86% of respondents supportive of expanding value-added small mill operator businesses and 78% of respondents supportive of attracting medium-sized mill operators, a focus on smaller mill operators can serve as the initial planning point for further mill expansion. Currently, only two small-mill operators produce forest products in Wrangell. To account for the corrected notice of intent for the Wrangell Island EIS, which reduced the proposed harvest volume from 80 MMBF to 60 MMBF, this study suggests cutting between 2.5 to 3.5 MMBF per year for 20 years .This would provide a cumulative harvest of 50 to 70 MMBF over the course of 20 years.

Justification for this recommended harvest comes from the current situation of timber harvest on the Wrangell Ranger District. The process for the Wrangell Island EIS has suffered serious setbacks with contractual complications, personnel turnover, agency-wide changes in planning procedures, congressional furloughs, and budget sequestrations so that a draft EIS has not yet been made available to the public after four years. During the course of that time, other micro-sales on the district have continued to pass through the entire NEPA process, timber sale preparation, sale advertisement, bidding, contracting, timber harvest, and milling. A successful example of such sales comes through the Roadside Environmental Assessment (EA) for the Wrangell Ranger District, which makes available a total of 500 MBF sold in small salvage, firewood, and green sawtimber limited to 50 MBF per timber sale. Currently, small mill operators can handle roughly 1 to 2 MMBF of timber per year (Mike Allen, personal communication, August 15, 2012). Medium mills such as the one opening in Petersburg require 15-20 MMBF per year, which will most likely come from multiple other districts as well as the WRD. Given the setbacks with the large timber volume EIS, the wiser management objective would be to gain NEPA clearance for smaller areas available for timber harvest.

This strategy does have its own set of drawbacks, since larger operators need a guaranteed steady supply of wood to secure financial investors. As well, the Roadside EA is constrained to timber volume along existing road corridors within reach of cable yarders, which is a quickly exhaustible supply. Although Wrangell residents were overwhelmingly supportive of maintaining and building new roads, small timber harvest operators have neither the equipment nor the financial backing to create roads on a large scale or to bring in large aerial equipment. Still, by offering smaller sales, this could incrementally increase the value-added timber industry sector in Wrangell while still meeting the desires of the local public by offering lower timber volumes in the immediate future rather than promising larger timber volumes at some indefinite point in the future. These recommendations do not account for limitations in timber availability, regulations and policy, or other resource sensitivity. These recommendations are just a small piece of the bigger puzzle to foster compromise and promote collaboration.

Although this case study focused on timber harvest attitudes and locations, the survey asked many questions relating to the Tongass Transition Framework. Respondents were supportive of thinning projects for wildlife and fish habitat (99%) as well as supportive of developing wood biomass products for renewable energy (90%). With the planning stages of the Wrangell Island EIS currently taking place, concurrent strategizing for future stewardship projects that account for social values and incorporate these types of restoration activities will help managers and community members navigate the transition smoothly.

As mentioned, recreation values and acceptable recreation uses were the most mapped markers by the most respondents, while ground timber harvest and helicopter timber harvest were two of the most mapped unacceptable uses. Of the 82 respondents who mapped recreation value, 49 mapped their maximum allocated values (5). This indicates that many Wrangell residents value recreation very highly. Relatively speaking then, residents in the community of Wrangell value more areas on the district for recreation than timber harvest. Yet, the USFS continues to put more money into timber budgets than recreation. While over $11.5 million dollars went into the timber program on the forest in 2012, timber only brought in $1.8 million, whereas recreation spent $6.8 million and brought in $2.9 million (USDA Forest Service, 2014). As well, the visitor industry in southeast Alaska provided 6,059 jobs and brought in $170 million in revenue during 2011, while only 262 people were employed by timber industry jobs with a revenue of $12.2 million (Juneau Economic Development Council, 2013). Although not all visitor services indicate visitors recreating on National Forest lands, visitors in Wrangell are just as likely to participate in hiking or wildlife viewing within the forest as they were to partake in shopping (Juneau Economic Development Council, 2013).

Beyond allocating money disproportionately based on the number of regional jobs created, forest managers continue to cut recreation budgets without adjusting forest revenue flows for inflation. An example of this is the current Tongass National Forest Sustainable Cabin Management EA, which seeks to retire at least one cabin from every district on the forest, including the WRD. In 2012, at least 898 visitor nights were spent in WRD cabins, with each one being utilized at some point in the year. With such high visitation rates, the economic effects of increasing recreation fees marginally (which have not been increased since 1998) would exhibit an exponential scale of return.

Finally, recreation may not only diversify the economy through providing visitor services, but it may also support subsistence lifeways fundamental to Alaskan culture. Over 18% of the values mapped within a 1 km radius of recreation values were subsistence values. When tested for spatial correlation, highly significant positive correlations were found at all scales (Appendix D, Figure D-2). Comments associated with recreation values for both paper and internet surveys often indicated recreation facilities being used as base camps for deer, moose, and duck hunting, as well as gill-netting and crabbing. These subsistence activities increase the resilience of the community through mixed-economies and increased food security.

The key to resilience comes from increased adaptive capacity – in the case of the community of Wrangell, this means economic diversification, with the forest providing services to multiple industries at a sustainable pace. As Wrangell transitions into this new regime, managers would serve the public best by focusing efforts on sustainable recreation projects that support subsistence lifeways and small-scale timber sales that emphasize stewardship and restoration.

4.4 Conclusion

Furthering the understanding of landscape values holds benefits for researchers, decision makers, and community members alike. Firstly, this study tested the validity of landscape valuation theories – specifically the construct validity of measuring spatial forest uses. Secondly, managers now have an added dimension of public comments that improve the efficiency of prioritizing management activities. Public participation through landscape values mapping has the potential to recognize conflicting uses. This information helps managers identify needs in educational efforts, establish a baseline for stakeholders' perceptions, and allows for greater transparency in decision making. Final results of landscape values methodology can also be used when assessing the community's adaptive capacity. For example, the community's desire to increase the value-added timber products industry may support further research into entrepreneurial interests regarding the establishment of value-added mills in Wrangell.

While this project focused on sectors identified in the Tongass Transition Framework, and issues identified through the Wrangell Island EIS, the PPGIS landscape values methodology can be utilized by other communities on the Tongass or by communities undergoing a similar transition in other forests. As the Tongass National Forest moves towards resilience-based ecosystem stewardship, understanding the relationships between values and attitudes can provide direction for navigating the transformation. Ultimately, understanding how to navigate one scenario of transformation may help in navigating other potential system transformations on the forest, such as climate change.

Conversely, although the process was site specific, national forests belong to the public, and landscape valuation is not a vote but a snapshot in time to gauge the socio-political environment at a local level. Although there may be irreconcilable differences in attitudes towards natural resources allocation that are beyond the scope of landscape values, this methodology is still an inexpensive tool that can be added to the toolbox for managers interested in not only increasing forest health but also accurately measuring the public's attitudes towards forest management activities. Given that the Tongass put $30 million dollars into timber projects annually previous to 2008 (Chadwick, 2007) and 75% of this budget went into the NEPA process (Beier, 2011), the cost of using landscape values may be a better investment to identify potential conflicts prior to litigation. In a nation that consumed 14.6 billion cubic feet of wood products and produced 12.7 billion cubic feet in 2011 (Howard & Westby, 2013), the production of timber as a renewable consumptive material is still salient to the well-being and livelihoods of the national public. Ultimately, while the ability of values to solve forest management issues is limited, using landscape values to bring these concepts into a spatial realm may serve simply as a catalyst for discussion and education. There will always be disagreement about resource extraction and allocation, but when used in conjunction with scientific research and other public planning tools, landscape values continue to foster the idea upon which the USFS was founded: that is to provide "the greatest good for the greatest number in the long run."

GLOSSARY

ANILCA	Alaska National Interest Lands Conservation Act of 1980.
Assigned values	Values that are assigned to an object within a specific context, relative to other objects.
Attitudes	The evaluative action of a person upon an object or entity (Vaske, 2008); perceptions of "good" or "bad".
BBF	One billion board feet. A board foot measures the volume of merchantable timber as a 1 inch thick by 1 foot long by 1 foot wide board.
EA	Environmental assessment, a public NEPA document to assess the necessity for a higher level of environmental analysis for actions taken on public lands.
EIS	Environmental impact statement, required by NEPA for any actions taken on federal lands which result in significant impacts.
Forest use preferences	An individual's cognitive preference for an activity taking place on public forest lands, such as site-seeing or timber harvesting.
GIS	Geographic Information Systems.
Held values	Enduring values important to a person regardless of situations or objects.
High-grading	Removal of the highest quality trees from a stand while leaving the lower graded trees.
Landscape values	"Assigned values that humans place on goods and services in a geographic sense" (Brown et al., 2002).
Log grading	The quantification of log quality and value.
Lumber	Sawn timber milled to specific lengths, widths, and heights intended for market.
MMBF	One million board feet. A board foot measures the volume of merchantable timber as a 1 inch thick by 1 foot long by 1 foot wide board.
NEPA	National Environmental Policy Act of 1969; requires documentation by federal agencies undertaking actions on public lands.

NFMA	National Forest Management Act of 1976.
Old-growth	The conditions of a stand which include a multi-layered canopy dominated by late-successional trees, patchy understory with downed woody debris, and standing dead snags.
PPGIS	Public participatory geographic information systems; a method utilized by public land managers to gather geographic knowledge or opinions from the public.
Pulpwood	Wood used in the production of pulp (e.g., wood chips).
Sawlogs	Harvested logs which meet the minimum diameter, length, and grade requirements for sawing into lumber.
Sawtimber	Standing timber which meets the requirements of sawlogs.
Silviculture	The science and art of tree growth, health, stand composition, and timber quality.
Spatial forest uses	Forest use preferences exhibited on a spatial scale, such as old-growth reserve designations.
Stands	A group of trees within a contiguous geographic area; may be even-aged or uneven-aged, single species or mixed species.
Timber	Standing trees suitable for harvest.
TTRA	Tongass Timber Reform Act of 1990.
USFS	U.S. Department of Agriculture Forest Service.
WRD	Wrangell Ranger District, located on Wrangell Island.

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APPENDIX A

Survey materials

- 3 sticker sheets – Values, Acceptable Uses and Unacceptable Uses
- Paper survey map
- Paper survey with invitation letter

Forest Values

Value		Definition	
Aesthetic value	A	I value this area because I enjoy the scenery, sights, sounds, smells, etc.	A A A A A
Biological Diversity	B	I value this area because it provides a variety of fish, wildlife, plant life, etc.	B B B B B
Cultural Value	C	I value this area because it is a place for me to continue to pass down the wisdom and knowledge, traditions and way of life of my ancestors.	C C C C C
Economic Value	E	I value this area because it provides timber, fisheries, minerals, and/or tourism opportunities such as outfitting and guiding.	E E E E E
Future Value	F	I value this area because it allows future generations to know and experience the area as it is now.	F F F F F
Historic Value	H	I value this area because it has places and things of natural and human history that matter to me, others, or the nation.	H H H H H
Intrinsic Value	I	I value this area in and of itself, whether people are present or not.	I I I I I
Learning Value	L	I value this area because we can learn about the environment through scientific observation or experimentation	L L L L L
Life Sustaining Value	U	I value this area because it helps preserve, clean, and renew air, soil, and water.	U U U U U
Recreation Value	R	I value this area because it provides a place for my favorite outdoor recreation activities.	R R R R R
Spiritual Value	S	I value this area because it is a sacred, religious, or spiritually special place to me or because I feel reverence and respect for nature there.	S S S S S
Subsistence Value	G	I value this area because it provides necessary food and supplies to sustain my life.	G G G G G
Therapeutic Value	T	I value this area because it makes me feel better, physically and/or mentally.	T T T T T

Sheet 1 of 3

Figure A - 1. Forest values sticker sheet for paper surveys

Acceptable Uses

Value		Definition	
Helicopter Timber Harvest	H	This area is acceptable for timber harvest using helicopters to access timber.	H H H H H
Ground-based Timber Harvest	G	This area is acceptable for timber harvest using conventional logging equipment which requires roads to access timber.	G G G G G
Roads	R	This area is acceptable for building new roads.	R R R R R
Subsistence Lifeways	S	This area is acceptable for subsistence hunting and/or gathering.	S S S S S
Recreation Facilities	F	This area is acceptable for installing new recreation facilities (i.e. trails, cabins, shelters).	F F F F F
Motorized Use	M	This area is acceptable for motorized recreational use (i.e., snowmachines, ATVs, motorboats).	M M M M M
Non-motorized Use	N	This area is acceptable for non-motorized recreational use (i.e., hiking, kayaking).	N N N N N
Old-growth Reserve	O	This area is acceptable for designation as an old-growth reserve.	O O O O O
Commercial Tourism	T	This area is acceptable for commercial tourism activities (i.e, guided trips).	T T T T T
Scenic Viewshed	V	This area is acceptable for designating as scenically attractive.	V V V V V
Energy Development	E	This area is acceptable for installing new electricity facilities (including transmission lines).	E E E E E
Wilderness or Wild/Scenic River	W	This area is acceptable for designation as Wilderness or a Wild and Scenic River.	W W W W W
Other Development	D	This area is acceptable for other types of development (please explain).	D D D D D

Sheet 2 of 3

Figure A - 2. Acceptable forest uses sticker sheet for paper surveys

Unacceptable Uses

Value		Definition	
Helicopter Timber Harvest	H	This area is NOT acceptable for timber harvest using helicopters to access timber.	H H H H H
Ground-based Timber Harvest	G	This area is NOT acceptable for timber harvest using conventional logging equipment which requires roads to access timber.	G G G G G
Roads	R	This area is NOT acceptable for building new roads.	R R R R R
Subsistence Lifeways	S	This area is NOT acceptable for subsistence hunting and/or gathering.	S S S S S
Recreation Facilities	F	This area is NOT acceptable for installing new recreation facilities (i.e. trails, cabins, shelters).	F F F F F
Motorized Use	M	This area is NOT acceptable for motorized recreational use (i.e., snowmachines, ATVs, motorboats).	M M M M M
Non-motorized Use	N	This area is NOT acceptable for non-motorized recreational use (i.e., hiking, kayaking).	N N N N N
Old-growth Reserve	O	This area is NOT acceptable for designation as an old-growth reserve.	O O O O O
Commercial Tourism	T	This area is NOT acceptable for commercial tourism activities (i.e, guided trips).	T T T T T
Scenic Viewshed	V	This area is NOT acceptable for designating as scenically attractive.	V V V V V
Energy Development	E	This area is NOT acceptable for installing new electricity facilities (including transmission lines).	E E E E E
Wilderness or Wild/Scenic River	W	This area is NOT acceptable for designation as Wilderness or a Wild and Scenic River.	W W W W W
Other Development	D	This area is NOT acceptable for any type of new development.	D D D D D

Sheet 3 of 3

Figure A - 3. Unacceptable forest uses sticker sheet for paper surveys

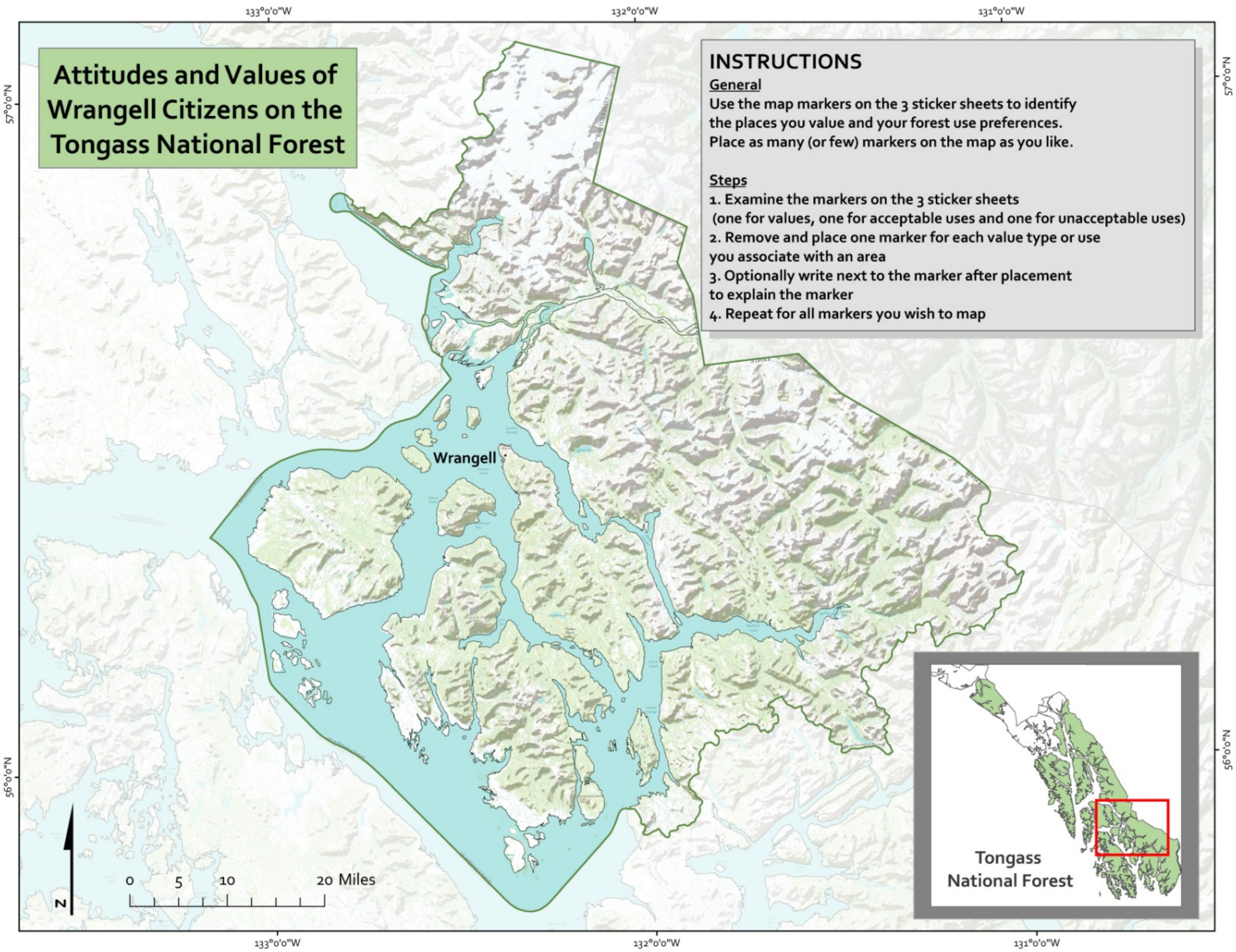

Figure A - 4. Map accompanying paper surveys (scaled down from 17 inches by 11 inches)

UNIVERSITY OF ALASKA FAIRBANKS
School of Natural Resources and Agricultural Sciences
303 O'Neill, University of Alaska Fairbanks, P.O. Box 757200, Fairbanks, Alaska 99775-7200
Phone (907) 474-7188 • Fax (907) 474-6567 • www.uaf.edu

March 1, 2014

Dear Wrangell,

Thank you for your interest in my survey. I have included an 8-page survey along with a 17 by 22 inch map. There are also 3 sticker sheets associated with this map. Please take the time to read the instructions within the survey as to how to complete this map. After you have completed the map and survey, please mail both back to me in the enclosed self-addressed, stamped envelope.

This survey is voluntary and the results of your survey will be kept anonymous. There are no risks connected with participating or not participating. If you have questions or concerns about your rights as a research participant, you can contact the UAF Office of Research Integrity at 474-7800 (Fairbanks area) or 1-866-876-7800 (toll-free outside the Fairbanks area) or fyirb@uaf.edu.

Everyone who completes a survey will be entered for a drawing of $300 gift card to be used at City Market/Sentry Hardware. Your unique user code in the upper right hand corner of the survey will be used to enter you for the drawing but will not be linked to your survey responses. The results of this survey will be available through City Hall, the Irene Engle library and the USFS Wrangell Ranger District office. Maps will also be posted at http://www.landscapemap2.org/wrangell/data_viewer.php

Thank you very much for your help in this project. Your input is very important. If you have any questions, please contact me at (907) 470-4555.

Sincerely,

Britta Schroeder

Britta Schroeder
Graduate Student
bjschroeder@alaska.edu

«Three_Digits»-«Four_Digits»

Figure A - 5. Survey sent to Wrangell citizens

ATTITUDES AND VALUES OF WRANGELL CITIZENS ON THE TONGASS NATIONAL FOREST

Thank you for your thoughtful responses on my survey. Below are some questions you may be asking about this survey:

What is this survey for?

This survey asks about your attitudes and preferences for management activities on the Wrangell Ranger District within the Tongass National Forest (TNF). This survey also asks about the areas you value on Wrangell Island.

What will this survey ask me?

The survey will ask questions in order to:

- Understand your familiarity with the Wrangell Ranger District (Section 1)
- Determine what uses you find appropriate or inappropriate on the Wrangell Ranger District (Section 2)
- Understand your attitudes about some important topics regarding the Wrangell Ranger District in the next 10-30 years, especially those related to timber harvest activities (Section 3)
- Discover how you value Wrangell Island specifically and what areas you value (Section 4)
- Determine how well distributed the survey was within the community of Wrangell (Section 5)

Why is this survey important?

The Tongass National Forest is a unique forest because it is the largest of the national forests and contains many valuable resources – both economically and ecologically. Managers use scientific data to manage these resources wisely. They also ask for public input so that they can better understand which uses are suitable in certain areas.

Why was I chosen for this survey?

You were chosen because you are registered to vote in Wrangell. Your opinion contributes to making informed, inclusive decisions about future forest management activities that impact the community of Wrangell.

How do I complete this survey?

It is important that the person to whom the survey was addressed completes the questionnaire. If more than one person in a household receives this survey, I ask that each person who received a survey still complete their own survey. Please answer all the questions in the survey. The average time to complete the survey and the map is 20 minutes. When you are finished, place the survey and the map in the enclosed stamped, self-addressed envelope and mail it back to me.

All participants who complete a survey will be entered for a drawing of $300 gift card to be used at City Market/Sentry Hardware. Your unique user code in the upper right hand corner of this survey will be used to enter you for the drawing but will not be linked to your survey responses. Results will not be reported in a way that might allow individual participants to be identified. Your voluntary participation is very much appreciated.

If you have any questions about this survey, please contact me:

Britta Schroeder
Graduate Student
University of Alaska Fairbanks
bjschroeder@alaska.edu
(907) 470-4555

«Three_Digits»-«Four_Digits»

Section 1: Your usage of the Wrangell Ranger District

The Wrangell Ranger District includes all islands south of Mitkof and Kupreanof, east of Prince of Wales; the mainland north of the Cleveland Peninsula, west of the Canadian border and the Stikine-Le Conte Wilderness. See attached map.

Q-1 How would you rate your knowledge of places on the Wrangell Ranger District? (Please select only one response).

Excellent
Good
_ Average
Low
Poor/little knowledge

Q-2 In the past 12 months, about how many times did you visit the Tongass National Forest within the Wrangell Ranger District? A visit is any time you purposefully entered forest lands to recreate or work.

_________ Times

Q-3 Do you or anyone in your household earn income from the sales of forest products or from commercial services that depend on access to the Tongass National Forest?

_ Yes
_ No
_ Unsure

Q-4 About what percent of your household's food is obtained from fishing, hunting or gathering within the Wrangell Ranger District? (Please do not include commercial fishing/shrimping/crabbing.)

______ %

Q-5 In general, how interested are you in what happens on the Wrangell Ranger District in the next 10-30 years?

_ Very interested
_ Moderately interested
_ Somewhat interested
_ Not interested

Q-6 How would you rate your knowledge of forest management activities on the Wrangell Ranger District? (Please select only one response).

_ Excellent
_ Good
_ Average
_ Low
_ Poor/little knowledge

Q-7 How easy/difficult is it to get information on forest management activities on the Wrangell Ranger District (i.e., timber sales, thinning contracts, motor vehicle plans)? (Please select one response)

Very Easy	Easy	Somewhat Easy	Neutral	Somewhat Difficult	Difficult	Very Difficult	No Opinion
1	2	3	4	5	6	7	9

Q-8 How useful is the information that you have gotten on forest management activities on the Wrangell Ranger District? (i.e., timber sales, thinning contracts, motor vehicle plans)? (Please select one response)

Very Useful	Useful	Somewhat Useful	Not at all Useful	No Opinion
1	2	3	4	9

«Three_Digits»-«Four_Digits»

Section 2: What do you think about the possible activities on the Wrangell Ranger District?

Q-9 How do you feel about these public uses on the Tongass, specifically the **WRANGELL RANGER DISTRICT**? Please tell me if you favor or oppose these uses. (Please circle only one response for each use)

#	Public Activities	Strongly Favor	Favor	Neither	Oppose	Strongly Oppose	No Opinion
1	Sight-seeing (including driving for pleasure)	1	2	3	4	5	9
2	Sport fishing	1	2	3	4	5	9
3	Non-motorized land-based recreation (e.g. hiking, skiing)	1	2	3	4	5	9
4	Sport hunting	1	2	3	4	5	9
5	Non-motorized water-based recreation (e.g. canoeing, kayaking)	1	2	3	4	5	9
6	Helicopter skiing/hiking	1	2	3	4	5	9
7	Wildlife viewing/observing	1	2	3	4	5	9
8	Motorized land-based recreation (e.g. snowmachines, ATV's)	1	2	3	4	5	9
9	Commercial mining	1	2	3	4	5	9
10	Motorized water-based recreation (e.g. boating)	1	2	3	4	5	9
11	Gathering forest products (e.g. berries, mushrooms)	1	2	3	4	5	9
12	Commercial outfitting/guiding	1	2	3	4	5	9
13	Communication site/utility easements	1	2	3	4	5	9
14	Wilderness	1	2	3	4	5	9
15	Subsistence hunting/fishing	1	2	3	4	5	9
16	Timber harvest activities	1	2	3	4	5	9
17	Other:	1	2	3	4	5	9

«Three_Digits»-«Four_Digits»

<u>Section 3: This section seeks your opinion about some important topics regarding forest management activities on the Wrangell Ranger District over the next 10-30 years, especially those related to timber harvest activities.</u>

Recently the U.S. Forest Service and other federal agencies created the Tongass Transition Framework for Southeast Alaskan communities. The goal of this framework is to promote economic growth in these communities and to restore health to lands and waters in the region. The Transition Framework identifies four management issues. These include: renewable energy, fisheries and mariculture (ocean products), recreation and tourism (visitor products), and forest products. Below are questions about your attitudes towards these issues **ON THE WRANGELL RANGER DISTRICT**.

Renewable Energy

Q-10 For each of the resources below, please indicate whether you agree or disagree that **WRANGELL RANGER DISTRICT** should invest money into developing these forms of renewable resources.

Forms of Renewable Energy	←Strongly Agree			-----------------Neutral-----------------			Strongly → Disagree	I don't know
Biomass (by-products of forest harvest activities, such as tree tops and limbs, which are turned into bricks or pellets for burning)	1	2	3	4	5	6	7	9
Hydropower	1	2	3	4	5	6	7	9
Biogas (Fish waste)	1	2	3	4	5	6	7	9
Geothermal	1	2	3	4	5	6	7	9

Visitor Products

Q-11 One of the goals of the Transition Framework is to increase access to the forest for visitors. Please indicate whether you agree or disagree with *each* of the statements below for the **Wrangell Ranger District**.

Visitor Access on the Wrangell Ranger District	←Strongly Agree			-----------------Neutral-----------------			Strongly → Disagree	I don't know
There are enough permits for outfitters/guides to conduct commercial visitor services.	1	2	3	4	5	6	7	9
The impact of outfitters/guides is minimal.	1	2	3	4	5	6	7	9

Forest Products

Q-12 People support or oppose different forms of logging on public lands for many reasons. Please indicate if you favor or oppose the different types of logging listed below for the **Wrangell Ranger District**.

Types of Logging	←Strongly Support			----------------------------Neutral----------------------------			Strongly → Oppose	I don't know
Clearcuts	1	2	3	4	5	6	7	9
Partial harvests	1	2	3	4	5	6	7	9
Individual tree removal								9
Helicopter logging	1	2	3	4	5	6	7	9
Ground based logging requiring roads	1	2	3	4	5	6	7	9

«Three_Digits»-«Four_Digits»

Q-13 Thinning of the young trees in a previously logged area may be done for many purposes. Please indicate whether you support or oppose thinning on the **Wrangell Ranger District** for *each* of the following reasons:

Purpose of Thinning	←Strongly Support	------------------------	------------------------	--Neutral--	------------------------	------------------------	Strongly → Oppose	I don't know
Wildlife habitat improvement	1	2	3	4	5	6	7	9
Fish habitat improvement	1	2	3	4	5	6	7	9
Production of wood products to be used solely for biomass (energy production)	1	2	3	4	5	6	7	9
Improve future commercial timber production	1	2	3	4	5	6	7	9

Wrangell Island Environmental Impact Statement (EIS)

The U.S. Forest Service recently identified areas on the Tongass that could support long-term sales as the timber industry transitions towards commercially harvesting second growth timber. One of these areas is Wrangell Island. An environmental impact statement (EIS) is a document that helps forest managers make decisions about the many alternatives related to timber harvests and road building. An environmental impact statement (EIS) is being prepared for Wrangell Island that may allow timber harvesting of up to 100 million board feet of timber over the next 10-30 years. The questions below ask your opinion on issues related to the Wrangell Island EIS.

Q-14 Roads provide access to recreation areas but can also damage wildlife and fish habitat. Please indicate if you favor or oppose *each* type of road activity listed below for the **Wrangell Ranger District**.

Road Activity	←Strongly Support	------------------------	------------------------	--Neutral--	------------------------	------------------------	Strongly → Oppose	I don't know
Creating more roads	1	2	3	4	5	6	7	9
Keeping current roads accessible	1	2	3	4	5	6	7	9
Closing roads for environmental protection	1	2	3	4	5	6	7	9
Closing roads for financial concerns	1	2	3	4	5	6	7	9

Q-15 The Wrangell Island EIS will identify how timber sales may affect potential deer habitat. This question asks how you would prioritize deer habitat and forest product jobs if you were making the decisions.

←Prioritize potential deer habitat over forest product jobs	--------------------	--------------------	--Neutral--	--------------------	Prioritize forest product jobs→ over potential deer habitat		I don't know
1	2	3	4	5	6	7	9

«Three_Digits»-«Four_Digits»

Q-16 Old growth reserves are areas designated for the protection of wildlife habitat. The Wrangell Island EIS will consider an alternative that proposes changes to the locations of old growth reserves. While the locations of these reserves could change, the acreage of old growth reserves would either still meet the standards of the forest plan or increase reserve acreage above the standards. Please indicate whether you favor or oppose changes to the locations of old growth reserves.

←Strongly Favor			Neutral			Strongly → Oppose	I don't know
1	2	3	4	5	6	7	9

Q-17 Many different alternatives will be presented in the Wrangell Island EIS. Please indicate whether or not you agree with *each* of the following statements for your preferred alternative.

Statements about your preferred alternative in the Wrangell Island EIS	**←Strongly Agree**			**Neutral**			**Strongly → Disagree**	**I don't know**
My preferred alternative would maintain forest products for the current value-added small mill operators on the island.	1	2	3	4	5	6	7	9
My preferred alternative would provide enough forest products to expand the value-added small mill operators on the island.	1	2	3	4	5	6	7	9
My preferred alternative would attract medium-sized mill operators.	1	2	3	4	5	6	7	9
My preferred alternative would attract medium-sized logging operators.	1	2	3	4	5	6	7	9
My preferred alternative would not require the construction of any new roads.	1	2	3	4	5	6	7	9

Q-18 Alternatives are currently being drafted for the Wrangell Island EIS. Alternatives like those below may appear in the Wrangell Island EIS. These are not necessarily the alternatives that will be presented in the Wrangell Island EIS. Please choose the hypothetical alternative you like best (Please choose only one. MMBF stands for million board feet. It takes about 750-800 spruce trees with an 18 inch diameter to make one (1) million board feet.)

_ No timber sales should occur
_ 10 years:50 MMBF cut at 5 MMBF per year (roughly 40 local jobs per year for 10 years)
_ 10 years:100 MMBF cut at 10 MMBF per year (roughly 75 local jobs per year for 10 years)
_ 20 years: 50 MMBF cut at 2.5 MMBF per year (roughly 20 local jobs per year for 20 years)
_ 20 years: 100 MMBF cut at 5 MMBF per year (roughly 40 local jobs per year for 20 years)
_ 30 years: 50 MMBF cut at about 1.5 MMBF per year (roughly 10 local jobs per year for 30 years)
_ 30 years: 100 MMBF cut at about 3 MMBF per year (roughly 23 local jobs per year for 30 years)

«Three_Digits»-«Four_Digits»

Section 4: Values

Q-18 For this question, you will use a map to identify places that you value on the **Wrangell Ranger District**. You will also identify areas for acceptable and unacceptable forest uses on the same map. Look at the enclosed 17 by 22 inch map of the **Wrangell Ranger District**. Note the three sticker sheets with definitions and abbreviated sticker dots. For every place you value, place a sticker dot with the corresponding value on the map. Do the same for uses, placing dots in areas with acceptable uses or unacceptable uses. You may place as many or as few stickers as you wish.

Example: You value both Pat's Lake and Rainbow Falls for recreation, but you also value Pat's Lake for the biological diversity. Place a blue "R" sticker at both Pat's Lake and Rainbow Falls, and place a blue "B" sticker at Pat's Lake. You also believe that subsistence hunting is acceptable near Pat's Lake. Place a green "S" sticker at Pat's Lake.

Section 5: Demographics

This section helps me know if my sample size is representative of Wrangell residents. This information is confidential, anonymous, and will be presented as statistics.

Q-19 Is your physical residence on Wrangell Island? (Please check one response)

— Yes, I live in the City of Wrangell
— Yes, I live at the Back Channel/Thom's Place/other
— No, but I live within Borough limits
— No, I live outside Borough limits

Q-20 How long have you lived in/near Wrangell? _____ YEARS

Q-21 How long have you lived in Southeast Alaska? ______YEARS

Q-22 What is your age? _____YEARS

Q-23 What is your gender? (Please check one response) _____MALE _____FEMALE

Q-24 What is the highest level of education you have completed? (Please check one response)

— Less than a high school diploma
— High school diploma or equivalent
— Technical/Vocational degree
— 4-year college degree
— Some graduate work
— One or more graduate degrees

☐ Please check here if you would like a copy of the results of this study mailed to you.

☐ Please check here if you do **NOT** wish to be entered for a drawing towards a $300 gift certificate good at City Market/Sentry Hardware.

Thank you again for your time in completing my survey.

«Three_Digits»-«Four_Digits»

APPENDIX B

Acceptable and unacceptable timber harvest use maps

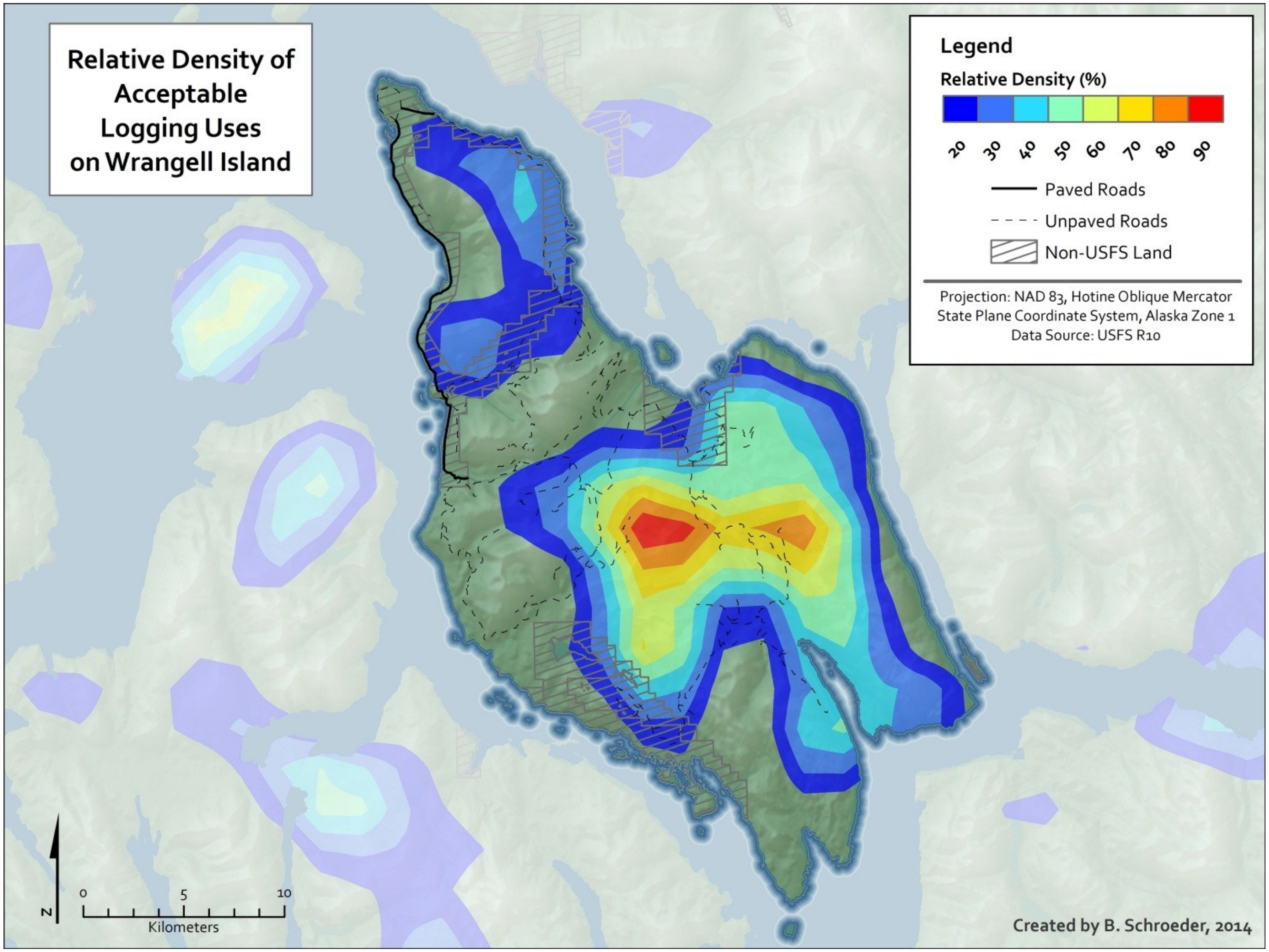

Figure B - 1. Acceptable Timber Harvest Use Normalized Relative Density Map

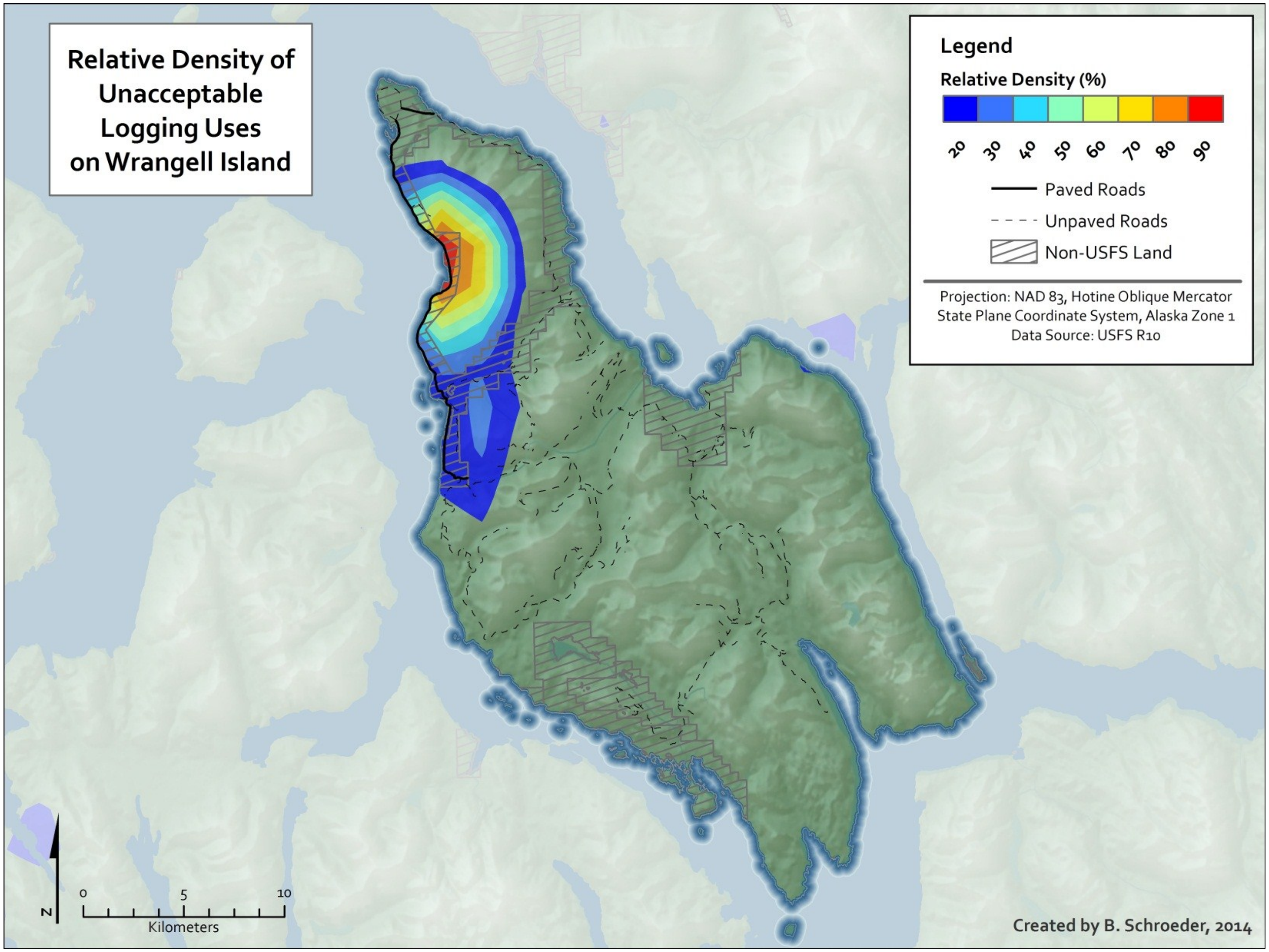

Figure B - 2. Unacceptable Timber Harvest Use Normalized Relative Density Map

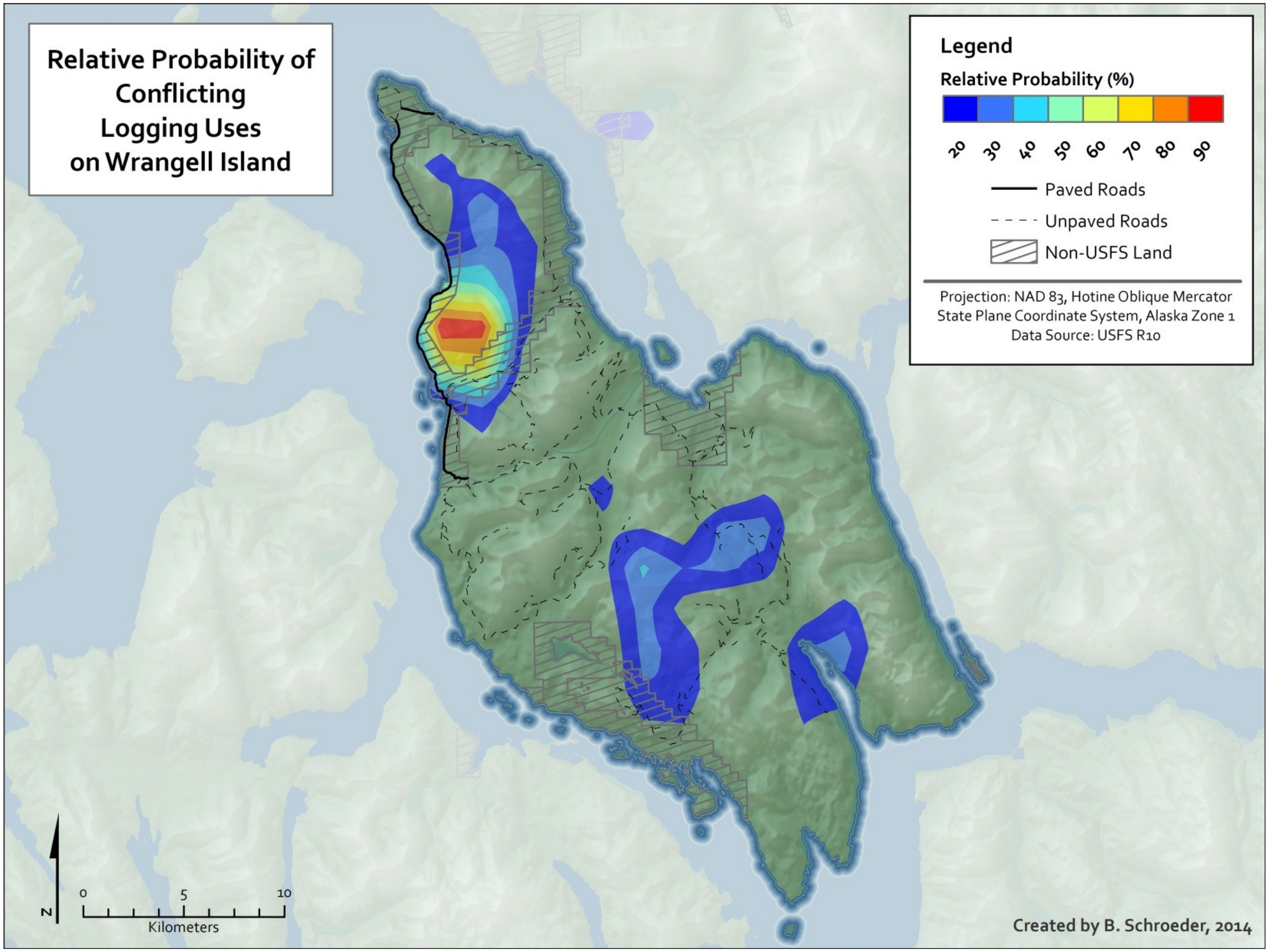

Figure B - 3. Relative Probability of Conflicting Timber Harvest Uses Map

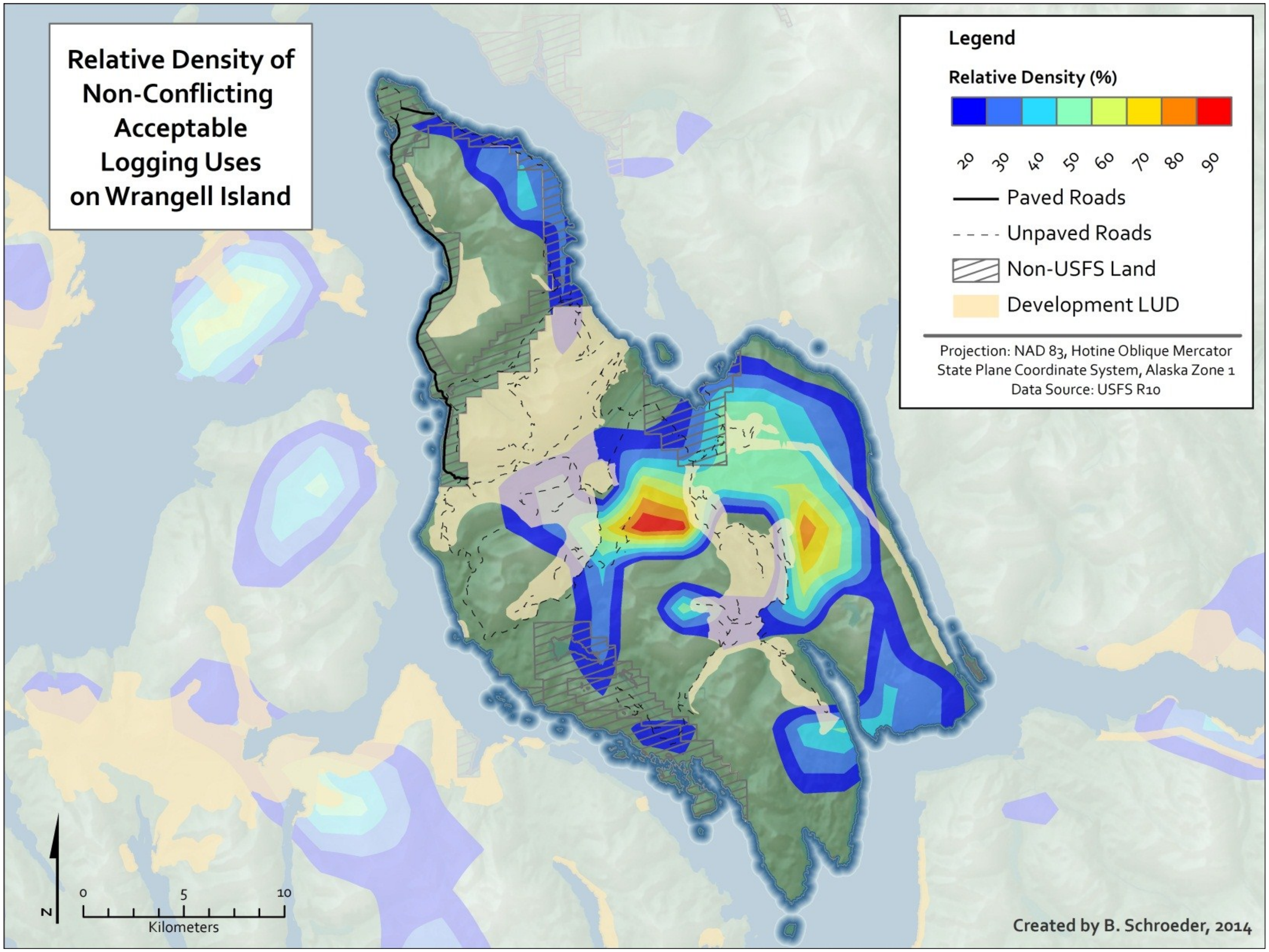

Figure B - 4. Acceptable Timber Harvest Uses Normalized with Development LUD's

APPENDIX C

Table of descriptive statistics for landscape values and acceptable/unacceptable uses mapped

Table C - 1. Descriptive statistics for values/uses mapped

Category Name	**Frequency**	**Frequency (by Percent)**	**Total number of respondents who mapped this value**	**Number of respondents mapping more than one value**	**Median Number of Values/Uses Mapped**
LANDSCAPE VALUES	**1802**	**49%**	**103**	**90**	**12**
Aesthetic value	249	7%	70	59	4
Biological value	153	4%	47	37	3
Cultural value	83	2%	30	20	3
Economic value	142	4%	43	31	4
Future value	86	2%	33	22	2
Historic value	94	3%	39	22	2
Intrinsic value	76	2%	27	17	3
Learning value	63	2%	24	14	2
Life sustaining value	67	2%	27	14	2
Recreation value	304	8%	82	64	5
Spiritual value	72	2%	28	14	1.5
Subsistence value	191	5%	53	42	4
Therapeutic value	112	3%	41	27	2

Table C- 1 continued

Category Name	Frequency	Frequency (by Percent)	Total number of respondents who mapped this value	Number of respondents mapping more than one value	Median Number of Values/Uses Mapped
ACCEPTABLE USES	**1466**	**40%**	**94**	**84**	**13**
Commercial tourism use	93	3%	35	21	3
Energy use	78	2%	33	21	2
Ground timber harvest	169	5%	51	38	4
Helicopter timber harvest	117	3%	34	27	4
Motorized use	178	5%	52	42	4
Non-motorized use	69	2%	26	17	2
Old-growth use	78	2%	25	18	3
Other development	31	1%	13	9	2
Recreation use	196	5%	60	45	3.5
Road use	154	4%	48	35	3.5
Scenic viewshed use	93	3%	33	22	2
Subsistence use	198	5%	56	44	4
Wilderness use	12	0%	8	1	1

Table C – 1 continued

Category Name	Frequency	Frequency (by Percent)	Total number of respondents who mapped this value	Number of respondents mapping more than one value	Median Number of Values/Uses Mapped
UNACCEPTABLE USES	**417**	**11%**	**58**	**37**	**5**
Commercial tourism use	24	1%	9	6	2
Energy use	15	0%	8	3	1
Ground timber harvest	104	3%	33	24	3
Helicopter timber harvest	72	2%	25	16	2
Motorized use	17	0%	10	3	1
Old-growth use	12	0%	5	3	2
Other development	61	2%	19	13	4
Recreation use	14	0%	7	3	1
Road use	69	2%	26	15	2
Scenic viewshed use	1	0%	1	0	1
Subsistence use	1	0%	1	0	1
Wilderness use	27	1%	12	7	2
Total	**3685**	**100%**	**NA**	**NA**	**23.0**

APPENDIX D

Graphs of standardized bivariate correlations between values and uses using Ripley's K-function

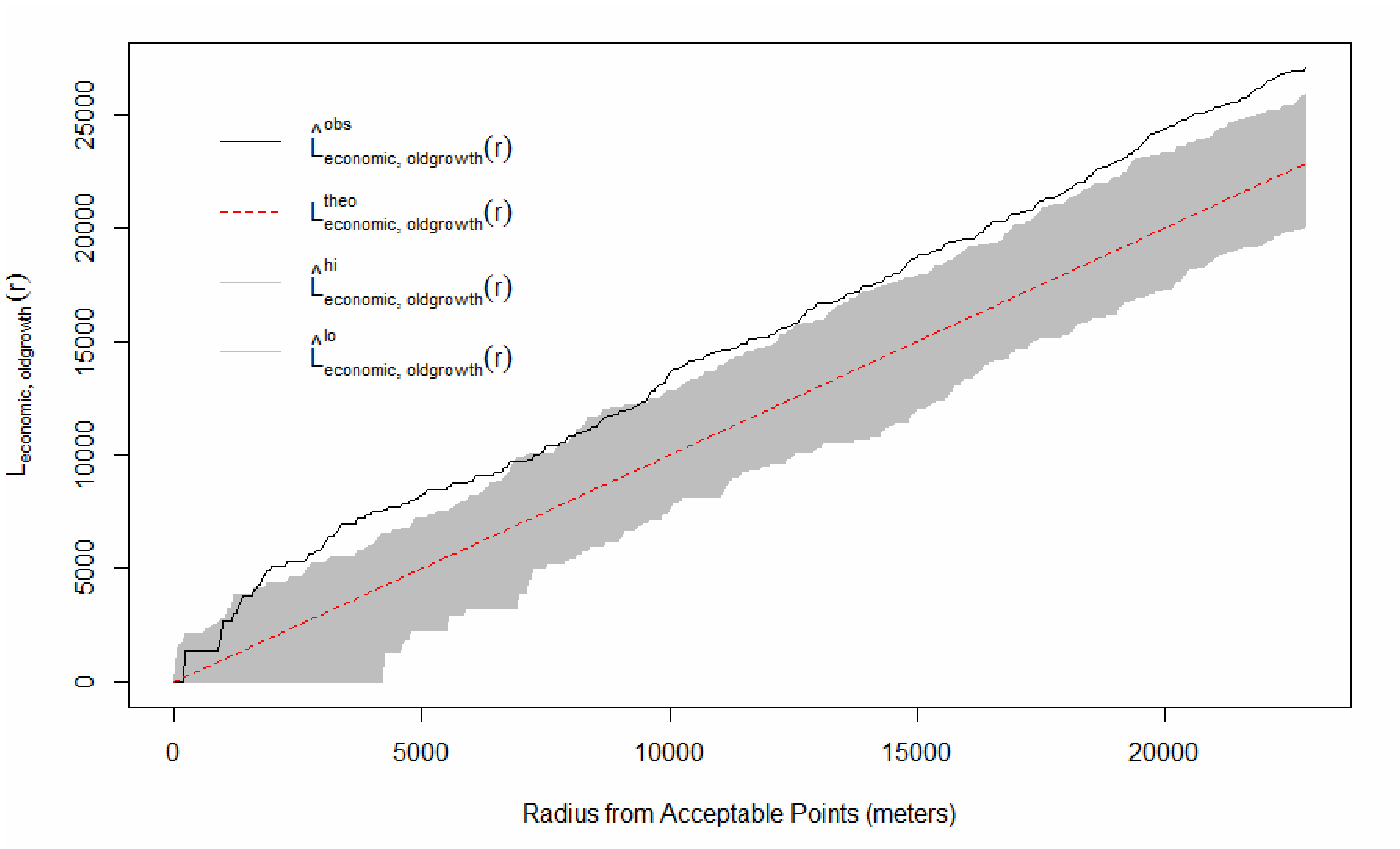

Figure D - 1. Standardized bivariate correlation between spatial economic values (n = 40) and spatial acceptable old-growth use (n = 38)

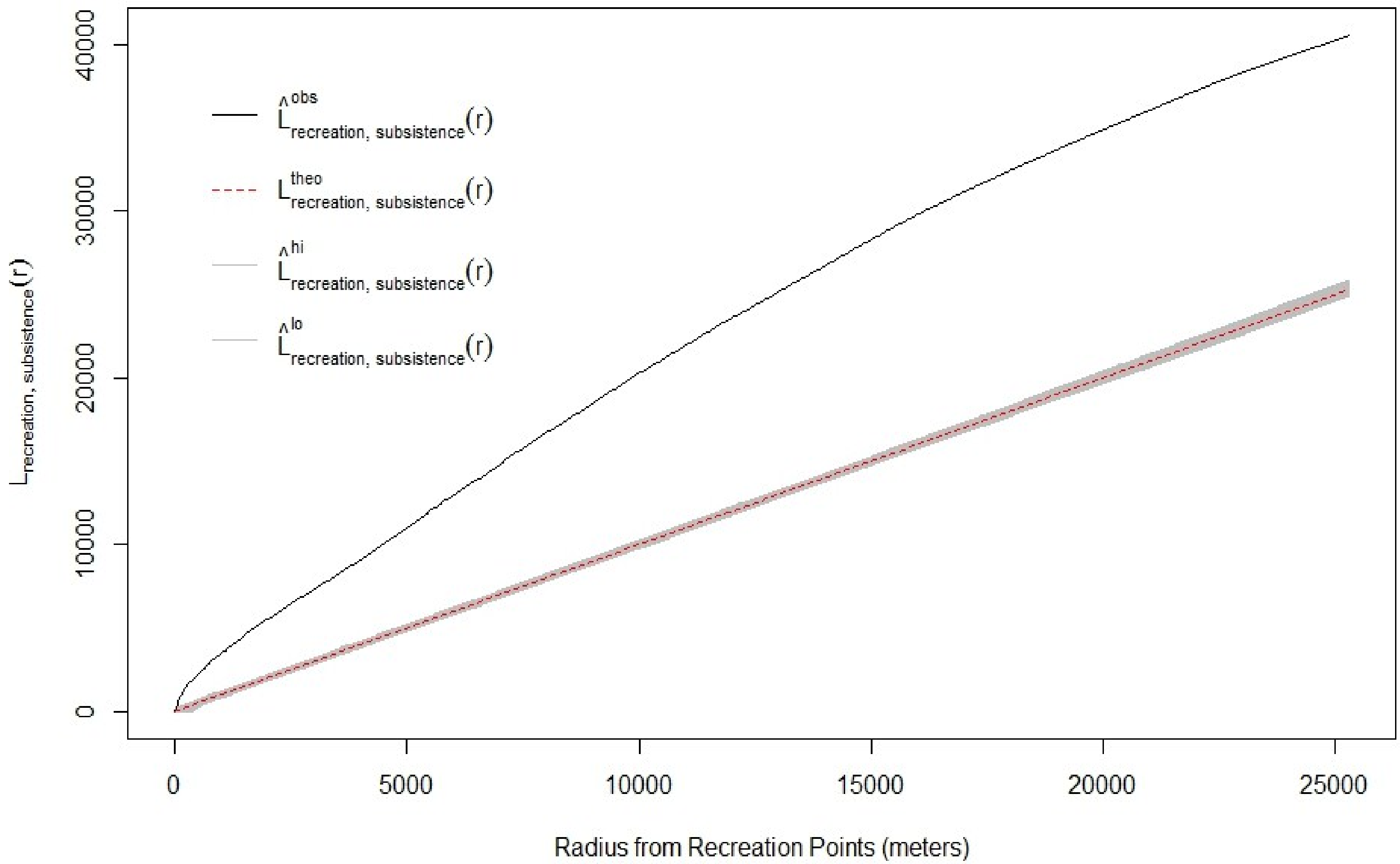

Figure D - 2. Standardized bivariate correlation between spatial recreation values and uses (n = 530) and spatial subsistence values and uses (n =401)